PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

MAR 2 ? 1932

SCIENCE

NEW SERIES
VOL. 75, No. 1943

FRIDAY, MARCH 25, 1932

SUBSCRIPTION, $6.00
SINGLE COPIES, 0.15

GLASS BLOWING SHOPS

Equipped with all conveniences for the most accurate work. Blue-prints are kept of the more detailed forms of apparatus, so that new apparatus or new parts can easily be supplied at any time.

Specialties:

Apparatus made according to Bureau of Standards, with or without certificate.

Extraction Apparatus, Soxhlets and many other types.

Gas Analysis Apparatus, such as Hempel Apparatus, Nitrometers, Orsats and Sulfur Testers.

Hydrometers, including Brix for percentage of sugar, A.P.I. for oil testing, a great variety of Baumé, Specific Gravity, and Twaddle Hydrometers, and Hydrometers for special uses.

Oil Testers, according to specifications of the A.S.T.M.

Physical Testing Apparatus, such as Conductivity Cells, Hydrogen Ion Electrodes, and many other special forms.

Stopcocks, one-way, two-way, three-way, and four-way, Mercury Seal, Failla, Internal Mercury Seal for High Vacua, and special forms.

Thermometers, including special thermometers according to the A.S.T.M., Precision Thermometers for Boiling Point, Freezing Point and Calorimetric work, also many styles of thermometers for special purposes.

Write for further details and specify your requirements re glass blown apparatus.

EIMER & AMEND

Established 1851 **Incorporated 1897**

Headquarters for Laboratory Apparatus and Chemical Reagents

NEW YORK, N. Y.
Third Avenue, 18th to 19th Street

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

Recent Issues from

California's Press—

Geological Sciences

Paleozoic Eruptive Rocks of the Southern Klamath Mountains, California
By NORMAN E. A. HINDS
Price, 35 cents

Cretaceous Beds at Slate's Hot Springs, California
By
JORGEN O. NOMLAND and HUBERT G. SCHENCK
Price, 25 cents

The History and Character of Volcanic Domes
By HOWEL WILLIAMS
Price, $1.00

Geography

Lower California Studies. IV
The Natural Landscape of the Colorado Delta
By FRED B. KNIFFEN
Price, $1.75 postpaid

Dry Climates of the United States
II. Frequency of Dry and Desert Years 1901–20
By R. J. RUSSELL
Price, $1.50 postpaid

University of California Press **Berkeley**

THE FACSIMILE TEXT SOCIETY

announces the publication of one of the earliest English books to plea for free-thought and experimental science, "The Vanity of Dogmatizing," first published in 1661 (this edition $3.50). It was written by Joseph Glanville, an Anglo-Catholic priest and member of the Royal Society † † † The modern scientist will be interested in the Facsimile Text Society which reprints books that are now inaccessible though they were once of the greatest significance. Many of these books are in the field of science † † † Membership in the Society ($5.00 a year) allows one the privilege of purchasing books at 25% discount, no charge being made for the first $5.00 worth of purchases † † † **Address all communications to the Facsimile Text Society, 2960 Broadway, New York City.**

CHARLES SCRIBNER'S SONS
NEW YORK ⁘ ⁘ LONDON
& PRINCETON UNIVERSITY PRESS

Henry Fairfield Osborn

Biological Series (1894-1929)

I. FROM THE GREEKS TO DARWIN
New and completely revised edition of this standard historical work on the rise of the evolution theory. 12mo. 3d thousand. $2.50

II. IMPRESSIONS OF GREAT NATURALISTS
Sequel to Vol. I. Darwin, Wallace, Huxley, Balfour, Bryce, Pasteur, Leidy, Cope, Butler, Burroughs, Muir, Roosevelt. With portraits. 12mo. New and extended edition. 4th thousand. $2.50

III. EVOLUTION AND RELIGION IN EDUCATION
Discussion with Bryan and other Fundamentalists of 1922–25. 12mo. 12th thousand. $2.00

IV. CREATIVE EDUCATION
"I rejoice that you have put your ripe experience into this brilliant book. It is tonic."—WILLIAM MCANDREW. Portraits. 12mo. 3d thousand. $2.50

Life History of Earth and Man Series (1907-1928)

I. THE ORIGIN AND EVOLUTION OF LIFE
On the theory of action, reaction, and interaction of energy. Profusely illustrated. 8vo. 12th thousand. $4.00

II. THE AGE OF MAMMALS
New and revised edition now in preparation. Profusely illustrated. 8vo. $6.00

IV. MEN OF THE OLD STONE AGE
Standard work in human archæology of the Palæolithic Age. Profusely illustrated. Thirteenth printing. Cr. 8vo. 24th thousand. $5.00

Published by Princeton University Press

V. MAN RISES TO PARNASSUS
Sequel to Vol. IV. Intellectual and spiritual evolution of man to close of the Neolithic Age. Illustrated. 8vo. 3d thousand. $2.50

Published by Princeton University Press

VI. COPE, MASTER NATURALIST
Life and Letters of Edward Drinker Cope. Foundations of natural history and vertebrate palæontology in America. Complete Cope bibliography, classified and annotated. Profusely illustrated. 8vo. $5.00

FIFTY-TWO YEARS OF RESEARCH, OBSERVATION AND PUBLICATION
Scientific biography; complete chronologic and classified Osborn bibliography, 1877–1930. Portraits. $1.50

THE TITANOTHERES OF ANCIENT WYOMING, DAKOTA AND NEBRASKA
Monograph 55 of U. S. Geological Survey. Vols. I and II, 882 pp., 797 text illustrations, 236 plates. Thirty years in preparation, a complete research in Geology, Palæontology, and Biology. 300 copies remaining of original 1600. $9.00. *Supt. of Documents, Government Printing Office, Washington.*

SCIENCE

VOL. 75 FRIDAY, MARCH 25, 1932 No. 1943

The Rôle of Hypothesis in Economic Theory: PROFESSOR GRIFFITH C. EVANS 321

Criteria and Methods in the Investigation of Avian Coccidiosis: DR. ERNEST EDWARD TYZZER 324

Scientific Events:

Summer Meetings of the American Association for the Advancement of Science; The Astrophotographic Building of the Harvard Observatory; Tests to Determine the Nature and Source of the Cosmic Rays; Conferring of the Chancellor's Medal of the University of Buffalo on Dr. Frank A. Hartman 328

Scientific Notes and News 330

Discussion:

Natural Radiations from the Great Bear Lake Pitchblende Deposits and Gene Mutations: W. C. BROADFOOT. *Possibilities of Secondary Poisoning of Birds and Mammals:* F. E. GARLOUGH and JUSTUS C. WARD. *Spread of Broad Fish Tapeworm of Man:* DR. WM. P. N. CANAVAN. *Discovery of Conodonts in the Phosphoria Permian of Wyoming:* DR. C. C. BRANSON. *Academic Freedom in Italy:* PROFESSOR A. J. CARLSON 334

Scientific Books:

Planck's Universe of Modern Physics: HENRY MARGENAU 338

Scientific Apparatus and Laboratory Methods:

A Modification of the Osborne-Mendel Salt Mixture Containing only Inorganic Constituents: DR. LAURENCE G. WESSON. *A New Kahn Antigen Mixer:* DR. CHARLES GURCHOT. *A Simple Method for the Study of Living Fresh-water Sponges:* DR. JAMES T. PENNEY 339

Special Articles:

Insects as Vectors of Yellow Dwarf of Onions: C. J. DRAKE, H. M. HARRIS and H. D. TATE. *The Pre-Oligocene Stratigraphy of Porto Rico:* HOWARD A. MEYERHOFF. *The Dependence of Physics on the Mathematical Preparation:* A. A. BLESS 341

Science News 10

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE RÔLE OF HYPOTHESIS IN ECONOMIC THEORY[1]

By Professor GRIFFITH C. EVANS

RICE INSTITUTE

THE distinction between a natural and a theoretical science lies essentially in the presence or absence of a free spirit of making hypotheses and definitions. In a natural science facts are recognized and systematized, with a purpose purely descriptive, but as the same field of knowledge is investigated in theoretical fashion, definitions become constructive rather than denotive, and hypotheses are introduced and tried out, in order to see what sort of results may be deduced from them. If the chains of deductive reasoning are complicated the science is driven to employ a characteristic method for their simplification. The mathematical method is at this point a requirement for progress.

[1] Delivered at a joint session of the Econometric Society and of Section K of the American Association for the Advancement of Science, January 1, 1932.

Mathematics itself is not always completely theoretical. In geometry, we still reason from "general" geometric figures, much in the manner described by Kant, and are content with that kind of reasoning until we encounter contradictions which force us to make a further analysis. Even when we know that a complete analysis is possible, and the nature of the system completely definable by more or less logical postulates and definitions, we are sometimes inclined, as mathematicians, to turn that analysis over to the logicians, and forget it.

The question naturally arises as to the degree to which we may speak of a theoretical economics, and the extent to which we may call it mathematical.

In the first place, we notice constructive definitions. We do not usually give such a definition of a concept like capitalism, contenting ourselves with denot-

ing the thing as it exists in certain systems, saying America and France are capitalist countries, but Russia is not. On the other hand, when we define rate of interest, rate of exchange, price, velocity of circulation, income tax, we have definitions given entirely in terms of previously acquired concepts. Terms which are in part given by means of earlier concepts and in part by referring to illustrations of them, so that their definitions are partly constructive and partly denotive, are those like monopoly and competition.

As far as a definition is constructive, relations may be deduced from it and other such definitions by a mathematical process. In this manner, from the definitions of price and velocity of circulation we deduce the "equation of exchange"; from the definitions of price and trade indices we express this same equation in another form. We can give the "dimensions" of all quantities fixed by constructive definitions. The mathematics of finance is obtained merely by using the definition of the rate of interest, and combining it with definitions of present value or value at an arbitrary time. Strange as it may seem to the novice, one or two such definitions may thus lead to an extensive body of real knowledge.

But we do not in this way exhaust the entire body of economic theory. In fact, we may say that the main object of economic theory is to make hypotheses, to see what relations and deductions follow from such hypotheses, and finally, by testing the consequences in comparison with the facts of existing economic systems, to describe them in terms of those hypotheses.

Demand is a concept which, according to Marshall, is destined to occupy continually increasing prominence in economics. What do we mean by demand? What hypotheses are connected with it? Perhaps we may say that the demand for a commodity is the amount of it which would be bought in unit time in a given "state" of the system. But then we must add some hypothesis or definition as to what constitutes the "state" on which the demand depends, for it is not practicable to have very many variables. We may, for instance, consider the following assumptions, which are not by any means a complete list of those which have practical meaning;

(1) $y = f(p)$, p the price of the commodity,
(2) $y = f(p, \frac{dp}{dt})$
(3) $y(t) = f(p(t-T))$, T a constant,
(4) $y(t) = f(p(\tau))$, τ all values between t–T and t,
(5) $y = f(p_1, p_2, \ldots, p_k)$, the p's being prices of several commodities.

We might perhaps start with (1) and make a simple approximate study of equilibrium, for in that case several of the possible hypotheses become identical, the prices being assumed to be mere constants. But if we extend our investigations to moving prices our results do not have the same degree of generality, but depend on the particular one of the hypotheses which we assume, these hypotheses for variable prices being all different. We must then for the sake of theory separate carefully the various systems which depend on different hypotheses, and not regard as results, in one system, conclusions which follow only from the postulates of another.

A central concept in economics has been that of utility. This has sometimes been regarded as a psychic quantity, to be identified with satisfaction or pleasure. But underneath such a definition there must lie assumptions, tacit or explicit. Even though we are not willing to assume that this psychic quantity is directly measurable, if we are to use it in equations we have nevertheless to be able to add small increments of it, to compare its rates of change, etc. What, for instance, would a writer like Jevons need to assume about it?

Let S stand for this satisfaction-quantity, let χ stand for a quantity of a particular commodity, and $\dot{\chi}$ for its increase per unit time. Following Jevons[2] we write U as the intensity of sensation or degree of utility, due to increase of $\dot{\chi}$, and regard it as a new kind of psychic quantity. We are supposed to be able to compare these degrees of utility or sensations for various quantities, and we regard U therefore as having some kind of dimension of its own, not necessarily calculable in terms of the dimensions of physical quantities. Let [U] be the dimensions of U, [S] the dimensions of S. Then the pleasure V caused per unit time by a rate of consumption $\dot{\chi} = d\chi/dt$ is a quantity like $U\chi$ and has dimension

$$[V] = [U]\,[\dot{\chi}] = \frac{[U]\,[\chi]}{[t]}.$$

But the total pleasure is like $\int V\,dt$ and therefore has dimensions

$$[S] = [Vt] = [V]\,[t] = [U]\,[\chi].$$

In other words:

$$[\chi] = \frac{[S]}{[U]}.$$

Accordingly, no matter what the commodity χ, its dimensions are given by the above formula. All commodities are quantities of the same dimensions. This means that we can evaluate a unit of one commodity in terms of the unit of another, in the sense

[2] Jevons, "Theory of Political Economy," Ch. III, IV, London, 1871.

at if the unit of pork is changed to one twice as rge, the unit of fountain-pens must also be changed one twice as large, in order for the economic equaons to have any meaning. How are appropriate nits to be found, in the first place? To say the ast, the situation is inconvenient.

Conceivably we object that the particular treatent given by Jevons is unnecessary, and that anher based on similar ideas would not necessarily volve the same difficulties—the difficulties arising om the fact that the intensities U are regarded as single kind of psychic quantity. We shall look at e situation therefore from a less restricted point of iew, and consider a theory which does not require e explicit use of any "psychic" quantity.

We leave out of account the question as to whether r not utility is itself measurable, but suppose that here is a quantity associated with it which is meaurable, and whose measure we may call an index of tility. If utility is measurable, the measure of utility self may be taken as the index of utility. Otherwise, e are in the same situation as when we take temperaure as an index function for warmth. For any tate of the system, accordingly, we assume that there s a number, which, with reference to the individual, ay be called the index of that state, and the indiidual's preference for one state or another is reflected in the magnitude of the corresponding index alues. If it is an index of utility each individual ries to make it a maximum. We have thus arrived at definite hypothesis, and many economists have tried o make it a basis for a general theory of economics.

We can make an estimate of the generality of such system. In the first place, it is essentially competitive. If we add all the individual index numbers together to form a social utility function, we can not say, although many have said so, that society as whole works to make this total function a maximum. For that is the same as saying that the maximum of sum is necessarily the sum of the maxima of the parts—which is absurd. Hence a cooperative aspect of the system—which is so pronounced in modern society—must be introduced as an extra hypothesis. Will this make too many hypotheses for the number of independent variables?

Consider the process by means of which such an index number may be set up. Presumably two situations which are widely different can not be compared, as they are, directly, but only through a process, consisting of small steps, by means of which one step is transformed into the other. That is, we do not compare directly the situation (x_1, y_1, z_1) with the situation (x_2, y_2, z_2), but the state (x, y, z) with the neighboring state $(x+dx, y+dy, z+dz)$. That is, we write

$$(6) \qquad dI = X\,dx + Y\,dy + Z\,dz$$

X, Y, Z being quantities that depend on the state (x, y, z), and then decide whether the change (dx, dy, dz) makes dI positive or negative or zero.

But now we encounter another difficulty. If the state is given by two numbers (x, y) we know that there exists generally a function I such that dI is positive, negative or zero according as

$$X\,dx + Y\,dy > 0,\ < 0 \text{ or } = 0.$$

It is obtained by a proper choice of the integral of the differential equation

$$X\,dx + Y\,dy = 0$$

In other words, we can build up an index function by means of the curves of indifference. But if the state of the system is given by three or more numbers we also know that there does not exist in general such an index function. The expression of this fact in mathematical terms is the statement that an equation like

$$X\,dx + Y\,dy + Z\,dz = 0$$

is not "completely integrable." If we wish to have a utility function we must introduce some hypothesis on the coefficients X, Y, Z.

One simple case is that emphasized by Pareto in which X depends only on x, Y on y, Z on z; for in that case we may write I as some function of the quantity

$$\int X\,dx + Y\,dy + Z\,dz$$

The general condition for three variables, in order that I should exist is

$$X\left(\frac{\partial X}{\partial y} - \frac{\partial Y}{\partial z}\right) + Y\left(\frac{\partial X}{\partial z} - \frac{\partial Z}{\partial x}\right) + Z\left(\frac{\partial Y}{\partial x} - \frac{\partial X}{\partial y}\right) = 0,$$

which seems to have no particular economic significance.

If this condition is not satisfied, and the general integration can not be carried out, the summation of $X\,dx + Y\,dy + Z\,dz$ from one state (x, y, z) to another will depend on the order in which the various increments dx, dy, dz are taken during the process. It will thus depend on the particular process by means of which we pass from the one state to the other, but not merely on the two states themselves. It has sometimes been stated that this summation nevertheless affords a satisfactory determination of I, on the ground that the process is regulated by the customs of industry and markets. But this again is the same as saying that certain relations already hold between the variables x, y, z, . . . ; and they are no longer independent. Moreover, if, in spite of these relations,

there remain three or more independent variables, the difficulty still persists.[3] Hence we must assume that all our situations relative to a utility function must not contain more than two independent variables, or else we must introduce directly a postulate of integrability. It seems an arbitrary limitation.

Having obtained or assumed such a function, let us suppose that we make it a maximum. We are inclined to set dI equal to zero, and without further consideration to regard the problem as solved. But if the maximum occurs on the boundary of the region of variation of the variables, as is likely, for instance, in the case of an individual who is trying to corner the market, there is no need for dI to be zero. Usually, also, there are various subsidiary conditions —restraints, "obstacles," necessary relations between the variables, which have to be satisfied at the same time. And altogether, these equations and the equations given by $dI = 0$ furnish as many equations as there are unknowns. But this is purely an automatic process. If we overlook a restraint, $dI = 0$ merely furnishes us one more equation than it did previously. It is absolutely no check on the correctness of statement of the problem that the number of equations is the required number.[4]

Finally, if we are to study group phenomena and distinguish between cooperative and competitive elements in the system, we must, as we have already remarked, introduce also group utility indices or group "ophelimities," and these have no transparent relation to the individual ones. The individual can not make his individual utility a maximum at the same time that society makes the sum of all the utilities a maximum, for the maximum of a sum is not in general the sum of the maxima of the separate terms. The group utility function can not, therefore, with this interpretation of the problem, be the sum of the utility functions of its members. And from this point of view the doctrine of "laissez faire" lacks mathematical foundation.

It is apparent, from what we have said, that the use of a utility function reduces us to the study of a very special case. The special case may, of course, be worth while. But in the terms heretofore used this study is entirely abstract; moreover, if it is to be made sound, it is dependent on the introduction of a number of special conditions which are not statable by means of economic concepts. The result is merely a collection of equations which have no relation to economics, except in the names that are used. Would it not be better than to abandon the use of the utility function, and investigate situations more directly in terms of concrete concepts, like profit and money value of production, in order to take advantage of the fact that money is fundamental in most modern economics and to use the numbers which it assigns to objects?

Concrete concepts suggest concrete hypotheses.

[3] This apparently is not a unanimous opinion among economists; *Cf.* the review of the author's "Mathematical Introduction to Economics" by Professor Henry Schultz (*Journal* of the American Association, December, 1931). It is assumed that a decision is possible as to which of two situations is preferable, or better, or more satisfying, even though each depends on several variables and without regard to processes of transformation; but we notice that this is itself merely the assumption of integrability. It is warrantable only for a limited class of problems. How many individuals, for instance, can decide, without reference to process, which of the two situations he desires—peace, or justice, in China?

[4] That we have the same number of equations as unknowns is a more or less adequate check on the correctness of statement of a problem when each relation comes directly from the problem or its intuitive analysis. At best the method is not satisfying, even when restricted to geometric or algebraic relations. But economists have been tempted to carry the idea over into these problems of maxima and minima, where, for the reasons given above, it is absolutely worthless.

CRITERIA AND METHODS IN THE INVESTIGATION OF AVIAN COCCIDIOSIS

By Dr. ERNEST EDWARD TYZZER

DEPARTMENT OF COMPARATIVE PATHOLOGY, THE MEDICAL SCHOOL OF HARVARD UNIVERSITY

WHILE the economic importance of coccidial infection in domestic fowls is quite generally recognized, much of the investigation in this field has yielded only conflicting results and all too little in the way of actual accomplishment. The chief difficulties appear to have been due to the failure to recognize that a number of distinct species of *Eimeria* occur in poultry, even in a single host species, and also to the failure to employ adequate controls. Thus the coccidial infections encountered in various domesticated birds have been commonly attributed to a single poorly defined species, usually alluded to as *"Eimeria avium."* While the usual text-book description of the coccidium life cycle appears to have been understood and widely utilized, certain well-established principles have been frequently ignored.

It is the purpose of this communication to review some of the methods employed by the author in previous work in this field and also to discuss certain criteria which have been found to have applica-

on in a more recent investigation carried on in collaboration with H. Theiler and E. E. Jones.[1] The recognition of the fact that a single avian host may harbor more than one species of *Eimeria* appears essential to a proper approach to this field of work. In order to learn the reaction of the host to each species of parasite, or indeed to determine to which ones the more serious disease conditions are attributable, it has been found advantageous to work with infections produced experimentally with single species. Since coccidia do not lend themselves to artificial propagation outside the bodies of their respective hosts, the determination of their specific characters makes it necessary to substitute for the test-tube of the bacteriologist a suitable experimental animal. Hence the isolation of a given species is accomplished by the selection of proper material, while its propagation is carried on by experimental infection.

Isolation may be accomplished in various ways. On occasion, infections with a single species of *Eimeria* present themselves, thus doing away with the necessity of artificial isolation. In such cases, sufficient acquaintance with the organism and a series of observations carried out on carefully conducted experimental infections are necessary in order to be sure that one is not dealing with mixed infections.

In some instances the selection of material from a given region of the intestine is all that is necessary to isolate a species. For example, in a mixed infection with *E. acervulina* and *E. tenella,* the fact that the development of the latter is commonly confined to the caeca makes possible the isolation of the former by collecting oocysts from the first portion of the intestinal tract. On the other hand, *E. tenella* may be isolated from such a mixture by taking the caecal mucosa for the source of oocysts after prolonged and thorough washing in running water to remove the *E. acervulina* oocysts that pass into the caeca from the small intestine. By this method we have been successful also in separating *E. necatrix* Johnson from associated *E. acervulina* infection.

By collecting the earliest oocysts to appear in an experimental mixed infection, it is possible to separate out the species having the shortest period of development. Likewise selection may be based on differences in the time required by the oocysts of various species to undergo sporulation.

In certain combinations of species, the most feasible method for the isolation of a species may be to obtain single oocysts. One way of accomplishing this is by the dilution method as employed by Miss Jones.[2] This is done by transferring material containing the mixture of oocysts into a succession of drops of fluid on a thin strip of moistened gelatin, which for convenience is placed on a sterile microscopic slide. When a drop is obtained containing a single oocyst of the type desired, the portion of the gelatin strip including the oocyst in question is then cut out and immediately fed to an uninfected bird. It will be readily understood, however, that it may be a time-consuming task to obtain by the dilution method an oocyst of a species which is poorly represented in a given mixture. Another method was employed when *E. maxima* was first encountered in a mixture with *E. acervulina,* in which its oocysts formed only a very small percentage of the total number present. Since the large size of the *E. maxima* oocysts rendered them readily distinguishable, single oocysts were isolated by the Barber micropipette, transferred to a small disc of moistened gelatin which was then lifted by sterile tweezers and placed far back in the pharynx of an uninfected chicken to make sure of its being swallowed.

Should a mixture of two organisms be encountered such as *E. tenella* and *E. necatrix,* which produce oocysts that are not readily distinguished one from another and that develop in the same portion of the intestinal tract, the most feasible procedure would appear to be to immunize birds against either one of the organisms which may be available in pure culture. Then on feeding the mixture of oocysts to the immunized birds, a pure strain of the other species may be obtained.

In reviewing the criteria that we have considered in recognizing species, attention should be called to the common fallacy of differentiating species on the measurements of oocysts. First of all, the measurement of oocysts furnishes no certain index as to the purity of the material. Slight representation of additional species may have no appreciable effect on the curve plotted and, unless other characters are taken into account, there is no means of knowing whether a curve obtained is typical of any species. There is also considerable evidence indicating the occurrence of size strains within a given species. It has been shown by Miss Jones[3] that an infection derived from a single oocyst furnishes oocysts that give a distinctly bimodal curve when the measurements are plotted and that this character is maintained throughout successive transfers. She has also shown that the oocysts may be larger in light infections than in heavy ones.

In view of such variation within a species, the consideration of other features in addition to the dimensions of the oocyst appears to be essential for the differentiation of species. For this purpose we have found the following characters useful: the

[1] A full account of this work is in the hands of the publishers and will appear in the *American Journal of Hygiene.*

[2] E. E. Jones, "Size as a Species Characteristic in Coccidia: Variation under Diverse Conditions of Infection." To appear in *Archiv für Protistenkunde.*

[3] E. E. Jones, *loc. cit.*

period required for development, *i. e.,* the time from the feeding of oocysts to the discharge of oocysts; the sporulation time; the gross topography of the infection; the distribution of organisms in the epithelium, *i. e.,* whether scattered or in colonies, superficial or deep, in free surfaces or in glands, *et cetera;* the gross and microscopic pathology of the infection; the morphology of the developmental forms of the organisms; and finally the absence of cross immunity. Notwithstanding this rather formidable array of characters, differentiation of the individual species is not difficult once they have been recognized, since certain combinations of characters are practically specific. Thus the occurrence of superficial, whitish, transversely extending, elongate spots composed of oocysts in the mucosa of the upper portion of the intestine furnishes a reliable indication of *E. acervulina,* while the ocurrence, in association with hemorrhage, of rounded whitish spots, occurring in greatest number in the middle portion of the intestine, seen best from the serous surface and composed of numbers of cells containing large schizonts furnishes a diagnosis of *E. necatrix.*

In addition to the difficulties arising from the confusion of species, the failure to recognize certain fundamental principles in many instances vitiates the results of investigation. In contrast to the experimental bacteriological infections in which no elaborate precautions for the isolation of stock animals are necessary, in experimental studies of coccidial infection, the possible occurrence of adventitious infection must always be taken into account. The ubiquity of coccidial infections, their possible introduction by the attendant, or in food material, or by insects, rats and mice, is apparently often disregarded. The demonstration that the ingestion of a single sporulated oocyst may result in infection serves to indicate the necessity of carefully planned controls for all crucial experiments in this field. While it seems to have been recognized that coccidial infection tends to be self-limited, the duration of single infections in the absence of any opportunity for reinfection appears not to have been determined heretofore. We have found that various Eimerian infections, even in the absence of any appreciable protective reaction on the part of the host, disappear spontaneously, following the completion of the developmental cycle. This type of infection, in contrast to bacterial infections, is thus dependent for its continuance on reinfection through the ingestion of oocysts. That a certain proportion of sporulated oocysts may pass through the intestine unhatched is often disregarded, although this fact may be readily demonstrated either by direct examination of fecal discharges or by placing control birds in the same cage with those fed oocysts.

That the severity of infection is primarily dependent upon dosage is also readily demonstrable; light infections with even the most pathogenic species furnish no symptoms and no more than microscopic lesions. The term "dosage," however, should apply to the number of infective forms which invade the tissues rather than to the number swallowed. Thus it has been found that approximately the same number of organisms fed to birds of one age will furnish a much heavier infection than when fed to birds of another age. It has been found also that greater protection is afforded the host by a heavy infection than by a light one. Among other things to be considered with reference to dosage is the movement of material through the alimentary tract of the bird. Material fed to the chicken commonly makes its appearance in the feces in slightly more than an hour's time. Since no very coarse material is ever found in the caeca, it is apparent that not all material passing through the small intestine enters these tubes, but there is a sampling of the more finely comminuted material. Thus many of the sporozoites of *E. tenella* hatching in the small intestine fail to enter the caeca and are lost in the fecal discharges, as may be demonstrated by microscopic examination. Likewise, by far the greater proportion of the merozoites produced in the small intestine by *E. necatrix* pass out in the feces. In fact, merozoites are regularly demonstrable in the discharges, even in light infections of this species.

There are certain precautions that should be taken as a matter of routine in experimental coccidial infection, and others that may be taken with special objectives in view. It is a fortunate circumstance that the day-old chicks which may now be purchased at all seasons of the year are usually free from coccidial infection. On arrival, they should be furnished a sterilized equipment, consisting of cage, heat unit, feed and water dishes, and thenceforth kept in a room apart from infected chickens. All mash, grit and litter which they receive thereafter should be made into packages of appropriate size and sterilized in the autoclave as a matter of routine. Water may be taken from the hot water tap. The attendant should have nothing to do with infected birds, which preferably should be personally cared for by the investigator. The rooms in which either stock or experimental birds are kept should be well screened and free from cockroaches, flies and other insects. Access of mice to cages and food material should be carefully prevented. Propinquity is another important feature to take into consideration; the activity of chickens in scattering material about makes accidental infection a matter of frequent occurrence, especially when lots of birds are kept in the same room with

other lots that are discharging oocysts. The proof of the success of measures to protect experimental birds from accidental infection rests on the freedom of stock from infection as determined by periodic examination of discharges. Accidental infection does not, however, necessarily vitiate one's results, especially if it is immediately recognized. The time of its occurrence may indicate an accidental infection, and its morphological characters may make possible its differentiation from the experimental infection.

The assumption that chicks kept on false cage-bottoms of wire mesh will not become reinfected is unwarranted. While this measure may lessen the opportunity for reinfection, nevertheless fecal material adheres to the wire so that it is likely to become mixed with scattered food and later ingested or it may contaminate the feet and be picked off subsequently by the bird. Fecal material is commonly found in food dishes, thus furnishing ample opportunity for reinfection. Practically the only way to prevent reinfection is to change to successive sterile environments at periods less than the sporulation time of the oocysts, *i. e.*, within each twenty-four hours. The continued absence of infection in normal control birds after their introduction into the cage with the infected ones furnishes evidence as to the efficacy of the above measures.

In the course of our investigations on immunity, the question arose as to whether the birds that were resistant to reinfection were also no longer discharging organisms. While it would appear that no test thus far tried out for the presence of organisms in the fecal discharges is wholly infallible, yet certain procedures carried out at frequent intervals probably furnish a reliable indication. Infection may be disclosed by the direct method of microscopic examination, by which may be discovered not only oocysts, but also merozoites, and it not infrequently happens, at least with some species, that the merozoites may be present when no oocysts are demonstrable. The flotation method of concentration, using strong salt solution, works well for determining the presence of oocysts, but after such treatment the oocysts are often unsuitable for subsequent transmission experiments. By keeping fecal discharges for two or three days in 2.5 per cent. potassium dichromate solution and then feeding the material to normal birds, it is frequently possible to demonstrate the presence of oocysts in material in which they could not be found microscopically. Since by this method the samples fed represent only a fraction of the discharges of the bird tested, it is quite possible that the existence of light infections may not always be discovered. Even on combining both the microscopic and feeding tests for the presence of infection, it can not definitely be demonstrated that a bird on a given occasion harbors no infection, for the discharge of organisms is subject to considerable fluctuation. However, in groups of birds such tests made repeatedly furnish an indication of the trends of infections, *i. e.*, whether increasing in intensity or dying out.

Failure to employ adequate precautions to prevent accidental coccidial infections or to recognize them when they occur doubtless accounts for many of the fallacies and ill-founded conclusions that appear from time to time. For example, reports on the transmission of coccidial infection to quite unrelated host species are not uncommon in the literature. A scrutiny of such reports yields no evidence of proper isolation of the test bird or sterilization of its food, while the possibility of the intestinal contents of the donor containing oocysts from other sources than itself appears not to have been considered. Concerning the latter possibility, Krijgsman's[4] success in infecting rabbits with *Eimeria stiedae* from the feces of rats that had been fed this organism is noteworthy. Another source of error is the failure to identify accurately the infection that may appear in the recipient in the course of cross-infection experiments. The mere occurrence of coccidial infection is hardly acceptable without definitely identifying it by further morphological and pathological studies. The time of occurrence of infection is of considerable significance, and in order to determine this, daily examinations for organisms in the discharges are necessary. Gross pathological features associated with coccidial infection should not be relied on without supporting evidence. For example, extensive fatal hemorrhage into the caeca and small intestine has been noted in turkeys, but we are not justified in regarding this as *E. tenella* infection without demonstrating organisms with the morphological and biological features of this species.

Unwarranted assumptions are frequently encountered in measures proposed for coccidiosis control. Thus the dipping of eggs for incubation purposes in antiseptics is advocated without determining whether it is possible for the oocysts to survive on the shell of the egg throughout the period of incubation. The absence of coccidia in most of the day-old stock on the market appears not to have been recognized. Furthermore, it is commonly assumed that coccidial infection, since it is of such serious consequence in poultry, should be wholly eliminated from the flock. The conclusion has been reached, however,

[4] B. J. Krijgsman, "Overbrenging en prophylaxis der coccidiose." *Tijdschr. Diergenessk.*, 56e (19): 1032–43. 1929. (Author's summary, *Biol. Abst.*, 5, No. 4, April, 1931.)

in our recent investigations that the exposure of birds to light infection early in life protects them against serious injury from infection later on.

Once the multiplicity of the species of *Eimeria* infecting poultry is realized and the basic principles of such infections are understood, there is probably no other group of hosts in which coccidiosis may be studied so advantageously. While it is a rather difficult matter to maintain stocks of young mammals free from all such infections, "day-old" chicks are now available in reasonably large numbers throughout the year, and young turkeys, pheasants, *et cetera*, may be obtained at certain seasons. The uniform susceptibility of such hosts, the ease with which infection is produced and the regularity of results under laboratory conditions, all lend themselves to accuracy in this field of work. It is reasonable to expect that much may be learned also by the application of exact methods of observation and experiment to the practical problems in coccidiosis.

SCIENTIFIC EVENTS

SUMMER MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SEVERAL years ago the council of the American Association for the Advancement of Science voted to hold summer meetings. The first of these meetings, held at Pasadena, California, last summer, will be remembered for its wealth of important scientific symposia and numerous excursions. Physicists, chemists and other scientists came from all parts of America to attend the scientific sessions held at that time.

The second meeting of this series of summer meetings will be held at Syracuse, New York, on June 20 to 25. For a meeting of national scope such as that of the association, Syracuse's geographical position is ideal. It is overnight from Eastern Canadian points, New England, New York, Washington, Baltimore, Philadelphia, Pittsburgh, Detroit, Cincinnati, and but slightly further from the South and Middle West. It is within 300 miles of one third of the population of the United States, and a ride of not more than eighteen hours will bring three quarters of the population of the United States to Syracuse. Such institutions as Syracuse University, Cornell University, the University of Rochester, Colgate University, Hobart, Wells and Union Colleges are within three-hour rides of Syracuse.

Preliminary indications are that the number of symposia at Syracuse will be much larger than the number at Pasadena. Extensive program plans are being made by a number of sections. Each of the fifteen sections of the association will plan to hold two or more sessions devoted to studies of special subjects. Already the programs of Section C (Chemistry) and Section N (Medical Sciences) are taking definite shape in this direction. Each local representative is working diligently with the secretary of the section which he represents. Indeed, the chairman of the local committee, Dean Hugh P. Baker, promises to replace any one who does not take an active part in the program planning. Only a few of the affiliated societies will meet with the Association at Syracuse, so that the section secretaries and the local representatives will be given the privilege of organizing the programs as they think best. Since the by-laws of the association forbid sections to hold programs competing with the programs of affiliated societies meeting with the association, this will offer to some of the section secretaries an opportunity which has never before presented itself.

The next summer meeting after that at Syracuse will be held in connection with the Century of Progress World's Fair at Chicago from June 19 to 30, 1933. The fair will make available a large sum of money which will enable the association to invite seventy-five distinguished foreign scientists whose expenses will be paid. From two to nine such guests will be invited for each section. It is planned to organize one symposium in the field of each of these distinguished guests and thus make it possible for American and European scientists to exchange views on subjects uppermost in their minds to-day. In addition to these sectional symposia, it is expected that the various affiliated societies meeting with the association at that time will hold sessions for the reading of papers.

Preparations for the World's Fair are rapidly nearing completion. The Hall of Science, covering five acres of land, will be the center of this mammoth undertaking. Indeed, here and throughout the fair the dependence of industry and civilization itself on science will be pictured. Nearly ten acres of floor space will be devoted to science exhibits.

CHARLES F. ROOS,
Permanent Secretary

THE ASTROPHOTOGRAPHIC BUILDING OF THE HARVARD OBSERVATORY

THE astrophotographic building of the Harvard Observatory was dedicated on Wednesday, March 23, and on that day there were scientific conferences and meetings in accordance with the following program:

I. MORNING SESSION. The Observatory Library at 10

o'clock. Conference on Astrophotographic Problems: Professor Harry H. Plaskett presiding.

The Harvard Collection: Dr. Annie J. Cannon, curator of astronomical photographs.

The Physics of the Photographic Process: Professor G. B. Kistiakowsky, department of chemistry, Harvard University.

A Survey of Photographic Astrometry: Professor Frank Schlesinger, director, Yale Observatory.

The Current Photographic Programs of the Harvard Observatory: Dr. Harlow Shapley, director, Harvard Observatory.

II. AFTERNOON SESSION. The Observatory Library at 2 o'clock.

A. Acceptance by President Lowell of the Keys to the new Astrophotographic Building from Mr. Charles A. Coolidge, president of the Harvard Alumni Association, representing the architects.

B. Conference on *The Time Scale*, under the auspices of the Harvard Chapter of Sigma Xi: Dr. Harlow Shapley presiding.

On the Concept of Time: Professor Percy W. Bridgman, department of physics, Harvard University.

The Astronomical Measurements of Intervals of Time: Professor Robert H. Baker, director of the observatory, University of Illinois.

The Age of Mankind: Professor Ernest A. Hooton, department of anthropology, Harvard University.

The Radioactive Base Line of Time Estimates: Professor Alfred C. Lane, department of geology, Tufts College.

The Geological Time Scale and its Applications: Professor Arthur Holmes, Durham University, England.

The Stability of the Solar System: Professor E. W. Brown, department of mathematics, Yale University.

Meteors and the Age of the Universe: Professor Ernst J. Öpik, Tartu University Observatory, Esthonia, lecturer in astrophysics, Harvard University.

C. Reception to members of Sigma Xi and invited guests in the director's residence.

III. EVENING SESSION. The Observatory Library at 8 o'clock. Joint Meeting of the Bond Astronomical Club and the Staff of the Harvard Observatory.

The Zodiacal and Planetary Symbols: Dr. Cecelia H. Payne, Harvard Observatory.

Astronomical Sketches: Members of the Bond Club and the Observatory Staff.

TESTS TO DETERMINE THE NATURE AND SOURCE OF THE COSMIC RAYS

DR. ARTHUR H. COMPTON, professor of physics at the University of Chicago, has left for Panama, where he will make the first of a series of tests in various parts of the world to determine the nature and source of cosmic rays. Dr. Compton's work will be part of a cooperative study, involving a dozen physicists working in several parties under his direction, to measure the intensity of the rays which apparently come from interstellar space.

The cosmic ray meter consists of a steel "ionization chamber," containing argon at 30 atmospheres pressure. The cosmic rays penetrating the chamber set up an electrical current in the gas (argon) which is measured with an electrometer. A series of lead and copper spheres, weighing in all 200 pounds, shield the ionization chamber from local rays, permitting only the cosmic rays to enter. The Carnegie Foundation and the University of Chicago will share the expense of the projected study.

The objective of the expedition, according to Dr. Compton, is "more complete knowledge of the nature and place of origin of cosmic rays. A survey such as this should give the most adequate test that has yet been devised to distinguish whether the cosmic rays are photons, such as light and x-rays, or electrons, such as give rays to the earth's aurora. Because of the effect of the earth's magnetic field, electrons would give less intense rays near the equator than near the poles, and presumably there should be other variations with the geographical location."

The present project continues work which Professor Compton did last October on Mount Evans, Colorado, and in the Swiss Alps. The new measurements will be made at altitudes ranging from 7,000 feet to 26,000 feet. The tests on Mt. Chico in Panama will be followed by studies at Huancayo, Peru. Mt. Cook in New Zealand, Mt. Kosciusko in Australia, Mauna Kea in Hawaii and Mt. McKinley in Alaska are the next objectives. At the end of the summer Dr. Compton will return by way of Colorado, where further studies will have been made.

Three other cooperating parties will report at the end of the summer. One will take measurements on the Volcano Lanin in Patagonia and at Punta Arenas in Chile. A second, in charge of Professor S. N. Naude, of the University of Cape Town, will climb Mt. Winterhoek in South Africa, and possibly Mt. Brukkaros. In India, Professor J. N. Benade, of Punjab University, Lahore, will go to Mt. Nunga Purbat in Kashmir, third highest peak in the world, and will, if possible, make tests at several altitudes ranging as high as 20,000 feet or more. Professor Benade will then proceed to Kandy, Ceylon; Singapore, Straights Settlement, and Mt. Tjerimai, Java, for further measurements.

Negotiations are also being made with several independent groups, which are planning expeditions to the

North and South Polar regions within the next two years for the inclusion of physicists in the parties to make further cosmic ray measurements.

CONFERRING OF THE CHANCELLOR'S MEDAL OF THE UNIVERSITY OF BUFFALO ON DR. FRANK A. HARTMAN

AT commencement exercises on February 22, the University of Buffalo awarded the chancellor's medal, its highest honorary badge, to Dr. Frank A. Hartman, professor of physiology in the School of Medicine, for his work in extracting the vital hormone of the adrenal cortex. Dr. Hartman is the first member of the faculty to receive the medal, since it is reserved for the few who by some outstanding act or achievement bring greater dignity and honor to Buffalo in the eyes of the outside world. An excerpt from Chancellor Capen's remarks in making the award follows:

The dominant function of the university is now no longer the preservation of the past; it is the creation of the future. How does the university create the future? By research, by experiment, by reducing the area of the unknown, by making new knowledge and reinterpreting old knowledge in the light of the new, and so furnishing society with new instruments to make life safer, more generous and more lovely. The terms "university" and "research" have come to be indissolubly associated.

But the situation contains a paradox. The university, especially in America, now has many obligations. Its historic obligation to transmit the past bulks large and is very costly. It has acquired still other obligations that are contemporary with the moment, that consume much energy and attract perhaps undue attention. In consequence, research, which experience has shown to be the university's most important activity, shares always disadvantageously in the apportionment of funds and facilities. Research is still far too often in the American university a work of supererogation. It is a surplus good work performed at the sacrifice of ease and profit, out of devotion to a wholly idealistic cause. It is performed by a minority of the members of the university. But from these works of supererogation, from this treasury of grace, if one may continue the theological figure, have come not all, to be sure, but a large proportion of those facts and points of view which within the last two generations have ameliorated and enlarged social living.

In the field of medical investigation the university has long had a practical monopoly. To university research in Europe and America the world owes most of the great discoveries that have controlled or vanquished one after another of the seemingly hopeless maladies to which humanity is subject.

Those who see only the occasionally spectacular results of research in the medical sciences have little idea of what lies behind them. In hundreds of laboratories all over the world the process is going forward, quietly, without public notice, almost as a matter of daily routine. It is not attended by sudden revelations. The advance toward the goal which the investigator seeks is inch by inch. Unexpected blockades and dashed hopes are frequent, and retreats to a point whence a fresh start can be made. There enter into the process imagination, bold and hazardous conjecture, the patient distrustful following of leads, the endless repetition of checks and tests to make sure that nothing has been overlooked and that the same procedures will bring every time the same results. For most workers this is all, this and the recognition by fellow workers of foundations solidly laid for the future advance of science.

Once in a while there comes to the rarely resourceful investigator brilliant success, then the applause of his professional associates, perhaps fame. Surely the man whose imagination and learning and technical skill have brought him to an important scientific discovery needs and wants no other reward. His cup is full.

But whether he wants it or not is beside the point. These institutions that are dedicated to research may properly seize the occasion to say: "This is what we mean. This is the business to which we are committed. This servant of the common good is our man, an exemplar of our craft."

For some months the University of Buffalo has been in a position to speak thus of one of its members. The discovery and preparation of cortin were in the best tradition of medical research. Years of baffling and painstaking experiment preceded the modest announcement of our colleague's success. Then, quite unheralded, followed the multiplying demonstrations of the effectiveness of the discovery; then renewed study and experiment, and at length national recognition modestly, almost reluctantly, accepted.

The university to which he has brought honor now delights to honor him. Fortunately it is able to present him with a tangible token of its approval. The medal established by former Chancellor Charles P. Norton was intended to signalize publicly just such distinguished achievement.

Frank Alexander Hartman, teacher, scholar, persevering and dauntless experimenter, discoverer of cortin, the council of the University of Buffalo awards the Chancellor's Medal to you, because through your investigations you have won rank among the leaders in the science of endocrinology and in so doing have "dignified Buffalo in the eyes of the world."

SCIENTIFIC NOTES AND NEWS

AT a recent meeting of the senate of the University of Dublin it was decided to confer the degree of Sc.D. on Dr. Ross G. Harrison, professor of comparative anatomy at Yale University.

ON the occasion of the dedication of the Graduate Education Building of the University of Chicago, the honorary degree of doctor of science was conferred on Dr. Edward Lee Thorndike, professor of educa-

tion and director of the division of psychology of the Institute of Educational Research of Teachers College, Columbia University.

THE honorary doctorate of the mathematical faculty of the University of Göttingen has been conferred on Lord Rutherford, director of the Cavendish Laboratory and professor of experimental physics at the University of Cambridge.

THE colloid division of the Brunswick Chemical Society has awarded to Miss Pockels the Leonard Prize for 1931, and the Brunswick Technical High School has conferred on her the degree of doctor of engineering, *honoris causa*. Professor Wilhelm Ostwald, of Leipzig, presented the medal and the rector of the Technical High School delivered the doctor's diploma.

AT the meeting of the Washington Chemical Society, held on February 11, the Hillebrand award was presented to Dr. G. E. F. Lundell, of the Bureau of Standards, for work in connection with his book on "Applied Inorganic Analysis." This award is given annually for the greatest contribution made by a Washington chemist during the year. The speaker of the evening was Mr. Arnold K. Balls, of the U. S. Department of Agriculture, who discussed the chemistry of enzymes.

DIPLOMAS of honorary membership were conferred upon Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and on Mr. Charles T. Main, consulting engineer, by the Boston Society of Civil Engineers at its eighty-fourth annual meeting on March 16.

DR. JULES SCHOKALSKY, of Leningrad, U.S.S.R., president of the Russian Geographic Society, was recently elected correspondent of the French Academy of Sciences, for the Section of Geography and Navigation. He is known for his oceanographic work, especially in the Black Sea.

AMONG members elected in the division of science of the Bavarian Maximilian order for science and art are Dr. Walther von Dyck, professor of mathematics, and Dr. Arnold Sommerfeld, professor of theoretical physics, both of the University of Munich.

THE Council of the Royal Society has agreed to recommend for election into the society the following seventeen candidates: Professor Frederick Charles Bartlett, Professor Davidson Black, Dr. Frederick William Carter, Professor William George Fearnsides, Professor Felix Eugen Fritsch, Professor Joseph Alexander Gray, Professor John Burdon Sanderson Haldane, Professor Douglas Rayner Hartree, Dr. Karl Jordan, Professor Frederick Robert Miller, Sir Basil Mott, Bt., Dr. John Boyd Orr, Professor John Lionel Simonsen, Mr. Thomas Smith, Professor Hugh Stott Taylor, Professor Herbert Westren Turnbull, and Professor Warrington Yorke.

THE annual faculty research lecture for 1932 at the University of California was given on March 22, Charter Day, in Wheeler Auditorium, by Dr. William Hammond Wright, astronomer of Lick Observatory. The title of the lecture was "Viewing the Heavenly Bodies through Colored Glasses."

DR. ARTHUR O. LOVEJOY, professor of philosophy at the Johns Hopkins University, has been appointed the second incumbent of the William James lectureship at Harvard University for the first half of next year. Dr. John Dewey, professor of philosophy emeritus at Columbia University, was last year the first William James lecturer under the foundation for psychology provided with nearly $800,000 by the will of Edgar Pierce, formerly instructor in psychology at Harvard.

PROFESSOR JOHN A. JAMES, who for the past thirteen years has been assistant dean of the College of Agriculture of the University of Wisconsin, has been appointed dean and director of the department of agricultural education. The position of assistant dean will be filled by Dr. Ira L. Baldwin, of the department of agricultural bacteriology.

DR. H. ROSSBACHER, formerly superintendent of manufacturing development at the Kearny plant of the Western Electric Company, has been transferred to the Bell Telephone Laboratories as manager of vacuum tube manufacture.

LEAVE of absence from Harvard University has been granted to Professor Hubert L. Clark, for the second half of 1931–32, in order that he may take charge of the expedition of the Museum of Comparative Zoology in Australia.

THE Hepsa Ely Silliman Memorial Lectures will be delivered at the Sterling Chemistry Laboratory, Yale University, by Professor Owen Willans Richardson, of King's College, London, on April 18, 19, 21, 22, 25 and 26, at 4:15 P. M. The subject of these lectures will be "Molecular Hydrogen and its Spectrum."

DR. ANTON J. CARLSON, professor of physiology in the University of Chicago, conducted the tenth annual graduate course, sponsored by the Toledo Academy of Medicine, from March 21 to 25, on recent advances in physiology. Dr. Carlson gave two lectures each day covering, among other subjects, the anemias, control of the heart, control of blood pressure, oxygen therapy, the digestive secretions, motor mechanisms of the alimentary tract, dietary deficiencies, the endocrine glands and renal function.

THE *Journal* of the American Medical Association

reports that Dr. Alphonse R. Dochez, professor of medicine, Columbia University College of Physicians and Surgeons, New York, gave the fifth course of lectures under the William Sydney Thayer and Susan Read Thayer Lectureship in Clinical Medicine at the Johns Hopkins Hospital, on March 22 and 23. Dr. Dochez spoke on "A Limited Consideration of Certain Aspects of Acute Infection of the Respiratory Tract."

DR. WALDEMAR T. SCHALLER, of the U. S. Geological Survey, recently has given three illustrated lectures before the department of geology and mineralogy of Columbia University on the potash deposits of New Mexico and Texas, the borate deposits in the southwest, and the crystal cavities of the New Jersey zeolite region. He also spoke on "The Potash Mine in New Mexico" before the American Institute of Mining and Metallurgical Engineers and on "Some Fascinations of Mineralogy" before the New York Mineralogical Club.

PROFESSOR ERNST WALDSCHMIDT-LEITZ, director of the institute of biochemistry, Deutsche Technische Hochschule, Prague, will give the Dohme Lectures on April 20, 21 and 22, at 4:30 P. M., at the School of Medicine of the Johns Hopkins University. The titles of his three lectures are: "On the Specificity and Mode of Action of Proteolytic Enzymes," "The Structure of Proteins," "On the Biological Significance of Enzymatic Activation."

THREE Cantor Lectures on recent researches on the nature and function of vitamins will be given by Professor J. C. Drummond on April 18 and 25 and May 2, at the Royal Society of Arts, London.

DR. COLEMAN R. GRIFFITH, associate professor of educational psychology at the University of Illinois, addressed the St. Louis University Sigma Xi Club on March 14 on "Some Studies on Exercise and Fatigue."

THE Sydney Ringer Memorial Lecture at University College Hospital Medical School, London, was delivered by Professor C. R. Harington on March 11 under the chairmanship of Sir Edward Sharpey-Schafer. The subject was "The Nature of the Secretion of the Thyroid Gland."

THE Biological Laboratory at Cold Spring Harbor, Long Island, New York, will inaugurate this summer a new course on plant sociology, which will take the place of field botany. As the name suggests, this course will be concerned with the recognition and description of plant associations and the investigation of their floristic compositions. Professor H. S. Conard will be in charge. Dr. A. J. Grout will conduct work in bryology.

PROMPT action on the part of both the House and the Senate has been requested, as Science Service reports, by the State Department and President Hoover, so that an $85,000 appropriation may be authorized to defray the expenses of the sixteenth session of the International Geological Congress to be held in this country in 1933. The House Committee on Foreign Affairs has already reported favorably on such an authorization. The congress was originally planned for 1932, but failure of the legislative branch of the government to authorize the funds last session caused a postponement. The committee report states: "The committee feels these congresses are very vital to the development of the resources of the world and that matters are discussed which eventually develop into action which means much to the financial condition of the country. . . . It is understood that this geological congress will devote considerable time to the discussion of copper, silver and petroleum."

MANSON HOUSE, the new headquarters of the Royal Society of Tropical Medicine and Hygiene in London, was declared open by the Prince of Wales on March 17.

ACCORDING to the *Journal* of the American Medical Association, the Council of the Royal College of Surgeons of England is presenting a hand-wrought and chiseled silver mace to the Royal College of Surgeons of Australasia. The staff is decorated with a pattern of English roses, Australian wattle and New Zealand ferns, and it is inscribed with the names of the twenty-four members of the council for the present year. The total weight of sterling silver is 189½ ounces troy, and the length is 3 feet 10⅜ inches. The mace will be presented to the Australasian body when Lord Moynihan visits Australia this year.

IT is reported that Harvard University will receive an endowment fund of more than $1,000,000 from the estate of the late Nelson Robinson, of New York City. It appears that Mr. Robinson had a life interest in this fund and that the principal will now go to the university.

SCIENCE SERVICE reports that representatives of 21 states have been attending the school for State Sanitary Engineers which the U. S. Public Health Service held at its stream pollution investigations station in Washington. The object of the school, which ended on March 26, was to acquaint these officials with the latest developments in laboratory methods and technique and other problems in their field. During the morning the "men" worked in the laboratories, where expert technicians demonstrated methods and unusual conditions. In the afternoon officers of the U. S. Public Health Service lectured on various problems of interest to sanitary engineers, such as stream pollution, malaria control, milk sanitation, water purification, unusual problems of public water supply

brought about by drought, and similar topics. Arrangements for the school were made jointly by Mr. E. S. Tisdale, sanitary engineer of the West Virginia State Department of Health, and Mr. J. K. Hoskins, sanitary engineer of the U. S. Public Health Service in charge of the station. The states represented at the school were: Arizona, California, Connecticut, Idaho, Illinois, Iowa, Kansas, Kentucky, Massachusetts, Minnesota, Missouri, New Hampshire, New York, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Texas, West Virginia and Wisconsin.

THE Field Museum of Natural History has received a large and important collection of plants gathered in Petén, Guatemala, and in British Honduras, made by Professor H. H. Bartlett, of the University of Michigan. The plants are being identified by Paul C. Standley, associate curator in charge of the museum's herbarium.

ACCORDING to the London *Times* the Oxford University Exploration Club is sending an expedition this year to North Sarawak instead of to Arctic Canada, where they worked last year. Mr. C. S. Elton, chairman of the club, reported recently that a biological survey of plant and animal life is to be made. The club is an undergraduate one, backed by experienced senior explorers and travelers. During the last four years expeditions have been sent to Greenland, British Guiana, Lapland and the Hudson Strait. The Sarawak expedition is backed by the university, which has made a small grant towards the cost, and it goes with the permission and approval of the Rajah of Sarawak, who is providing special facilities. Eight or ten members of the expedition are going from England about the end of July, and the leader in the field will be Mr. I. Banks, curator of the Rajah of Sarawak's Museum at Kuching. They expect to return before the end of the year. The district where most of the work will be done is around the Baram River. Camps will be made in the forest and in the mountains, and a special collection of plants will be made and brought back for further study at Oxford.

PLANS are being prepared for a building for the Polar Research Institute at Cambridge, which is part of the Captain Scott memorial. Dr. Seward, master of Downing College, who has himself done scientific work in the Arctic, stated recently that building would probably start about midsummer and should be ready early next year. Money raised as a memorial to Captain Scott was handed over to the University of Cambridge on condition that a Polar Research Institute was founded and that a suitable building was erected within ten years. The institute itself was established seven years ago and has been doing useful work in inadequate surroundings. Now, however, thanks largely to a gift of £4,000 from the Pilgrim Trust, there is enough money to carry out the original condition and erect a suitable building.

Two new primitive areas in the national forests of California have been set aside by Mr. R. Y. Stuart, chief of the Forest Service. These areas are known as the Devil Canyon-Bear Canyon area, 56 square miles in extent and embracing the entire drainage basins of Devil, Bear and Chileno Canyons in the Los Angeles National Forest, and the San Rafael area, 117 square miles in extent and located on the main crest of the San Rafael range in the Santa Barbara National Forest. Both these areas are accessible by trail only, and will be preserved as far as possible in their present wild state. No roads will be constructed and no permanent structures will be allowed except such as are necessary for protection and administration of the forests.

AT the Hôpital St. Louis, Paris, according to the regular correspondent of the *Journal* of the American Medical Association, a large radiologic service has been created that embodies all modern improvements. The minister of public health attended in person the opening of the new service. The institute was erected through the initiative of Dr. Belot, director of the service, who supervised himself all the details of the construction. A thick wall sheathed with sheets of lead insulates completely the roentgen apparatus from the booth occupied by the patients and the operators. The operators control the apparatus from a distance. The floor is entirely insulated by a thick layer of rubber. In addition to numerous dressing rooms for the patients, there are three rooms for radiologic diagnosis. The physician dictates his observations to secretaries, seated in an adjoining room, by means of a microphone and loud-speaker. The roentgenologist is enclosed in a special booth that assures him absolute protection. A powerful generator enables the operator to make roentgenograms of the lung at the rate of one every 2/100 second. Dummy lifts are used to transfer the plates at once to the laboratories on the ground floor, where they are immediately developed and then placed in an electric drier. The radiotherapeutic service comprises ten rooms. The patients are enclosed in a booth and the nurses control the apparatus from without, while they supervise the patient through a small window in the wall. There are two sets of equipment for superficial roentgenotherapy, an apparatus for moderately penetrative roentgenotherapy, and three sets of equipment for high voltage roentgenotherapy with 250 kilowatts. The generators are coils with a constant tension of 30 milliamperes. The Coolidge tubes, standard type,

are enclosed in opaque containers. In other rooms are the various types of apparatus for physical therapy: mercury lamps, diathermic devices, arc lamps, and the like; the filing cabinets; in addition, there are assembly and recreation rooms. Foreign physicians who visited the institute at the time of holding of the International Radiologic Congress stated that nowhere else is there an institute so complete and so modern. From the standpoint of capacity, 10,000 patients a year can be given diagnostic examinations and 30,000 patients can receive widely divergent forms of treatment each year.

WE learn from the London *Times* that the Royal Horticultural Society marked its one hundred and twenty-eighth birthday on March 7 by the unveiling of a plaque commemorating the foundation of the society. The plaque was placed on the face of Messrs. Hatchard's building in Piccadilly, and within the shop will be hung an illuminated record. The Horticultural Society of London was founded on March 7, 1804, at a meeting summoned by Mr. John Wedgwood and held in a room of Messrs. Hatchard's. The society received a Royal Charter on April 7, 1809, and in 1861, under the presidency of the Prince Consort, a new Charter was granted and the style and title altered to the Royal Horticultural Society. In 1899 a supplementary Charter was granted to meet the altered conditions, and this in turn was displaced by a new Charter in 1928. The society's first meetings were at Hatchard's. In 1818 it acquired offices in Regent Street, in 1859 in St. Martin's Place, Trafalgar Square, and in 1861 in South Kensington, after the society had taken over the gardens at the site where the Natural History Museum now stands. In 1888 the offices were removed to Victoria Street and the shows held in the Drill Hall of the London Scottish Volunteers. In the centenary year, 1904, the society built its present offices and hall in Vincent Square. In 1928 the growth of the society demanded a new hall, and this has been built in Greycoat Street, close to the old hall, where the office accommodation and library have been brought up to modern requirements. The society has always maintained a garden for the practical side of its work: in its early days at Kensington, then at Ealing, and later at Chiswick. In 1903 Sir Thomas Hanbury gave in trust the gardens at Wisley. The fellowship of the society is now about 27,000.

ACCORDING to regulations approved at a meeting of the faculty of the division on February 18, reported in the *Journal* of the American Medical Association, graduation in medicine eight years after entering college, instead of the present nine years, will be possible at the School of Medicine of the Division of Biological Sciences at the University of Chicago, with the beginning of the spring quarter. The intern year will be included in the eight years. Abolishment of the bachelor of science degree as an admission requirement was also approved. For admission to the medical school, adequate training in physics, chemistry, biology and mathematics is recommended, in addition to a reading knowledge of German or French. After 1933, a reading knowledge of German will be required. It is expected that this preparation will ordinarily be completed in the first year in the division. Selection by the committee on admissions will be based on character, aptitude and scholarship. Evidence of interest and ability in research will commend applicants to this committee. Requirements for the granting of the degree of doctor of medicine, as approved at this meeting, provide that group examinations be abandoned and general departmental examinations be substituted for them. The student will be required to pass a general departmental examination in each department during the quarter in which he completes his work in that department. The requirement of a thesis for graduation is abolished. The degree of doctor of medicine with honors in one department will be given when, in addition to meeting with distinction the requirements for the degree of doctor of medicine, the student has also completed a satisfactory thesis constituting a contribution to knowledge. This degree will be awarded on recommendation of the department and approval of the faculty of the division. The official name of the medical school will be the School of Medicine of the Division of the Biological Sciences.

DISCUSSION

POSSIBILITIES OF NATURAL RADIATIONS FROM THE GREAT BEAR LAKE PITCHBLENDE DEPOSITS ON GENE MUTATIONS

THE possibility of radiations from the earth in producing gene mutations was indicated by the recent work of Babcock and Collins[1] in California and by Hanson and Heys[2] in Missouri. This prompted the

[1] E. B. Babcock and J. L. Collins, "Natural Ionizing Radiation and the Rate of Mutations," *Nature*, 124: 227–228, 1929.

[2] F. B. Hanson and Florence Heys, "A Possible Relation between Natural (Earth) Radiations and Gene Mutations," SCIENCE, n.s. 71, 1828, 43–44, 1930.

writer to point out the possibilities of the recently discovered pitchblende deposits at La Bine point in the Echo Bay region of Great Bear Lake in the Northwest Territories, Canada.

The former compared the rates of occurrence of sex-linked lethal mutations in *Drosophila* in a street-car tunnel in San Francisco, where the natural ionizing radiation was fully twice as great as the radiation in their laboratory at Berkeley. The difference in the rate of occurrence of lethal mutations in the tunnel and in their laboratory, which was 2.5 times the probable error, although probably not statistically significant, is indicative.

The latter, working independently of Babcock and Collins, arrived at a somewhat similar conclusion. After unsuccessfully searching with an electroscope in the Ozark caves and lead mines in Missouri for a location with sufficient increase of ionization over that of the laboratory, they finally utilized an abandoned Carnotite mine in Colorado. The radiation in this mine was 0.39 times as intense as that from one mg of radium when the rays were passed through a 0.156 inch lead filter. Male *Drosophila* flies were exposed for 40 hours in this mine. It was found that the difference in the occurrence of gene mutations between tests and controls was 2.09 times the probable error. Although the results of these two independent experiments are probably not statistically significant, they would seem to suggest that more definite results might be obtained from more strongly ionizing radiations.

From electroscopic tests of eight samples of pitchblende from La Bine Point, Echo Bay, Great Bear Lake, N.W.T., Spence,[3] mineral technologist, Department of Mines, Ottawa, found that the uranium oxide content ranged from 27.88 to 83.90 per cent.; the equivalent range of radium content would thus be approximately from 70.79 to 213 milligrams per ton. Complete chemical analysis of two samples are also given in tabular form. The intensity of radiation from these outcrops[4] of pitchblende would undoubtedly be much greater than the intensity of radiation in either an abandoned Carnotite mine in Colorado or a street-car tunnel in San Francisco.

Considering the work mentioned, it has occurred to me that biologists might profitably investigate the Great Bear Lake pitchblende deposits from the viewpoint of observing gene mutations produced under conditions there. Evidence of this in the flora and fauna indigenous to the district, which includes species of Picea, Betula, Alnus, Ericads, mosses, liverworts and lichens, as well as numerous insects, might be observed in addition to exposing introduced biological entities, such as insects, mosses, fungi and other plants of known genetic constitution, to the action of these natural radiations.

The inaccessibility of the field, some 700 miles north of Edmonton, practically only accessible by airplane, and the lack of the necessary funds and material for this type of investigation has practically placed this very interesting possibility beyond the scope of the writer. No doubt this field would yield some very interesting data in regard to the rôle of natural radiations as a factor in the evolution of species by furnishing hereditable variations upon which the forces of nature could act.

W. C. BROADFOOT
DOMINION LABORATORY OF PLANT PATHOLOGY,
UNIVERSITY OF ALBERTA,
EDMONTON, ALBERTA

[3] Hugh S. Spence, "Radium-bearing Minerals from Great Bear Lake, North West Territories," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 48: 1–4, 1931.

[4] Hugh S. Spence, "Occurrences of Pitchblende and Silver Ores at Great Bear Lake, N.W.T.," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 51: 1–6, 1931.

POSSIBILITIES OF SECONDARY POISONING OF BIRDS AND MAMMALS

IN the winter of 1915, during jack-rabbit poisoning work in Lake County, Oregon, a coyote in the characteristic position of strychnine poisoning was found dead at a haystack. Portions of mutilated carcasses of rabbits that had been poisoned were lying near-by. In most cases the stomach and intestines were the only parts of the rabbit left untouched, but occasionally these also had disappeared. The stomach contents of the coyote found dead were examined and found to contain the stomach of a rabbit together with the contents. It is not common for a coyote to eat the viscera of rabbits. This was a case of direct poisoning from swallowing the poisoned bait in the rabbit stomach rather than secondary poisoning from eating strychnine in the flesh.

The lean meat of several rabbits that had been poisoned with strychnine was fed a dog and some chickens without producing any ill effects.

Hawks have often been observed to eat ground squirrels and prairie dogs so poisoned, without apparent ill effects.

Indians on some of the Indian reservations have been reported to have eaten ground squirrels poisoned with strychnine, without any unpleasant after effects.

Reports have been received that occasionally a dog has died suddenly after eating the bones of a poisoned rabbit that had been exposed for months to the

weather. Laboratory analysis of such bones has shown minute quantities of strychnine present in them. Before being killed, however, very few rabbits ingest sufficient strychnine that enough would be deposited in the bones to kill a dog.

After eating ground squirrels affected with bait materials poisoned with thallium sulphate, a number of coyotes have been found dead or having the symptoms of thallium poisoning. A small percentage of the squirrels when affected with thallium will sit at the entrance of their burrows in a stupor, and the coyotes easily catch them and eat the whole carcass. If they happen to catch one that has eaten a large quantity of grain within twelve hours, they may obtain some of the thallium on the grain. This would greatly reduce the number of squirrels they would have to eat to obtain a lethal dose. The number of squirrels in this condition, or of squirrels that die on the surface when thallium is used, is small in comparison with the original number of squirrels. Rarely skunks have been found dead that were suspected of having been killed by secondary poisoning on areas treated for ground squirrels with thallium-poisoned grain. That so few carnivores are affected by thallium in rodent control operations is probably due to the large number of poisoned rodents they would have to eat to obtain a lethal dose, and the difficulty in securing the number that would be required.

Very seldom has a bird of prey been found dead on or in the vicinity of areas from which the squirrels had been removed with thallium. On the Peckham Ranch, Santa Cruz County, California, on March 13, 1927, an eagle was observed that showed symptoms of thallium poisoning. Of several eagles that were feeding on the same area it was the only one affected and was found dead on the 21st.

To obtain some definite information under controlled conditions on the secondary poisoning of hawks with strychnine and thallium, a study of their resistance to these poisons was made at the Control Methods Research Laboratory, at Denver, Colorado. Early in July of 1928 a young Swainson's hawk was obtained and held in a large cage until December, 1928. Observations of the hawk's habits of feeding revealed the fact that it would readily take two medium-sized wild rats at a feeding, but that any number in excess of two would usually be killed and saved for future use. Thirteen small rats were consumed, however, in a two-day period. Medium-sized rats were considered those weighing 150 to 300 grams; small rats 40 to 125 grams.

In the period from December 12 to 17, this hawk was continually fed wild rats that had been killed with thallium iodide. Ten rats were eaten, and these ten rats contained 42.70 mg of thallium as the iodide. As the hawk weighed 1.24 kg this represents a dose of 34.43 mg/Kg. No symptoms of poisoning were noted.

Then on the successive days of February 13 and 14, 1929, the hawk was fed a total of 13 rats, which contained 153.37 mg thallium as the sulphate. The bird weighed 1.36 kg, so this dose was 113.00 mg/Kg. This showed no symptoms of poison.

On May 27, a rat was injected with 100.00 mg of arsenic as the trioxide and fed to the hawk. For two days after this dose of 73.70 mg/Kg the bird was somewhat listless and had no appetite, but by the 30th of the month normal appearances had returned. So on June 13 a rat carrying 200.00 mg of arsenic was given to the hawk. This dose of 147.40 mg/Kg failed to produce any toxic response at all.

On June 19 a rat was injected with 500.00 mg of strychnine as the sulphate, and fed to the hawk. It was taken rather slowly, but all was gone on the morning of the 20th. This was a dose of 368.00 mg/Kg of strychnine, and the hawk was in evident distress most of the day. The symptoms manifested, however, were confined to difficult breathing, stiff legs and extreme nervousness.

Regardless of this condition, the hawk's appetite was still good on the 20th, and it ate a rat that had been killed by an injection of 300.00 mg. of thallium as the sulphate. This was a dose of 220.00 mg/Kg, since the hawk had been practically stationary in weight for some time. On the morning of the 21st, the bird's appearance was entirely normal. On the 22d, it took a rat readily. The first signs of illness appeared on the 23d. On the 24th the bird was almost comatose with eyes closed and the wing drooped.

On the 25th, the hawk's condition was improved, and ate a new-born wild rat. A relapse occurred on the 26th, but the appetite was still good and three infant rats were eaten. By the 27th the bird was unable to stand. Posterior paralysis was well developed. No appetite. Condition was unchanged during the day of the 28th. Hawk died in asphyxial spasm at 9:15 A. M. on the 29th.

During its experimental career, this hawk survived 34.43 mg/Kg and 113.00 mg/Kg thallium; 73.70 mg/Kg and 147.40 mg/Kg arsenic; 368.00 mg/Kg strychnine. And finally lived for 9 days after a dose of 220.00 mg/Kg of thallium.

These figures indicate how extremely unlikely it would be to kill a hawk of this kind by secondary poisoning under field conditions. An ordinary small mammal, such as a ground squirrel, weighing from 1/4 to 1/3 Kg is killed by 3 to 10 mg of Strychnine; 10 to 25 mg arsenic; or 8 to 15 mg of thallium. As-

suming then that the mammal had eaten the larger quantity of poison listed, a hawk like the one tested could eat more than 50 squirrels that had been killed with strychnine; more than 8 that had been killed with arsenic, and about 20 that had died from the effects of thallium, providing it did not obtain any of the ingested poisoned grain.

With this resistance to strychnine the hawk would be practically immune to danger from secondary poisoning from such a toxic agent.

These experiments indicate that the bird would be forced to live entirely for about three weeks on mammals dying from thallium to obtain a lethal dose. This estimate is made disregarding the rate of elimination of poison that would be made by the mammal, which factor should double the number of animals needed to provide a lethal dose for the bird.

These results in laboratory experiments lead to the following conclusions:

Arsenic has no great secondary poisoning hazard, and is too erratic in its results to be a good rodent poison, consequently it is not used in large field-control operations.

Strychnine presents no danger of secondary poisoning to hawks.

Thallium is apparently more hazardous, but even this cumulative poison can kill hawks only in extraordinarily large doses, unlikely to be obtained under field conditions.

F. E. Garlough
Justus C. Ward

Control Methods Research Laboratories,
U. S. Bureau of Biological Survey

SPREAD OF BROAD FISH TAPEWORM OF MAN

The finding of *Diphyllobothrium latum* (Linn., 1758), the broad fish tapeworm of man, in Oklahoma should be of interest to parasitologists. It is known that this species was brought to the United States by the Swedes and Finns who settled in Minnesota and North Dakota, where the proper intermediate hosts for its development abound. Hegner, Root and Augustine[1] write: "In the United States *Diphyllobothrium latum* has been considered a rare parasite occurring only in emigrants from European endemic centers. However, a number of indigenous infections have been reported recently from Minnesota, Illinois, Indiana, Michigan and Massachusetts." The above-mentioned states are all in the northern tier of states. The occurrence of this tapeworm in Oklahoma shows a wider distribution for the species.

Recently a thirty-one-year-old laborer called at the Oklahoma Medical School Hospital clinic for treatment. He stated that he believed he had a tapeworm because he recognized the signs and that he knew people got them from eating dried fish in the old country, as he had done. He stated that he was a native of Finland and has been in America fifteen years, coming to Oklahoma three months ago from Louisiana. This is interesting, because the tapeworms taken from him must have had a length of life of over fifteen years, provided of course that he became infected in his native land. Riley[2] stated a Swedish woman was definitely known to carry the infection for thirteen years.

Upon examination he was found to have numerous ova in the stool, to have bloody diarrhea, to be very anemic and weak, with attendant colicy pains. These pains he claimed doubled him up and kept him from work. Dr. A. D. Danielson treated him with oleoresin of aspidium and salts. At the first treatment twelve feet of proglottids was obtained. Later fifteen to twenty feet was obtained. All the segments showed the characteristic grayfish color and coiled brown uterus centrally located. By careful search two heads were found. These were unarmed and had two bothria or slit-like suckers. Upon the patient's release, "feeling much better," he was told to come back in two months to be checked.

As this host came from Finland not more than fifteen years ago, it is evident that carriers are still actively transporting this parasite across the ocean and spreading it farther in the United States, and that the migration of Finns, and perhaps Swedes, in search of work in new areas is a large factor in its spread.

The danger of this species becoming indigenous to the southern states seems remote, due to the absence of cold water lakes and proper intermediate fish hosts. The possibility remains, however, that *D. latum* may adapt itself to different intermediate hosts from those now known for it and hence become endemic in new areas.

Wm. P. N. Canavan

Bacteriology Department,
Oklahoma Medical School

DISCOVERY OF CONODONTS IN THE PHOSPHORIA PERMIAN OF WYOMING

During the summer of 1931, the Phosphoria formation along the east front of the Wind River Mountains, Wyoming, was examined for microfossils. The Phosphoria is Pennsylvanian and Permian in age, the boundary coming below the Pustula member. This member contains a bed of low-grade rock phosphate

[1] R. W. Hegner, F. M. Root and D. L. Augustine, "Animal Parasitology," 731 pp. New York, 1929.

[2] Wm. A. Riley, "The Longevity of the Fish Tapeworm of Man, *D. latus*," *Jour. Parasitol.*, 5: 193, 1919.

which weathers rapidly into rounded grains. About 1 per cent. of these grains were found to be conodonts. This is the highest known stratigraphic occurrence of the conodont group.

The Phosphoria types are peculiar and are apparently senile specializations of a rapidly declining group. They seem to bear the same relationship to other conodonts that the late Cretaceous ammonites do to other ammonoids and that Silurian and Devonian trilobites do to other trilobites. There are at least two types of ribbed spoon-like teeth and one type of plate-like tooth with longitudinal lines of denticles. Simple conical forms are abundant. The species will be described and figured in a later paper.

C. C. BRANSON

BROWN UNIVERSITY

ACADEMIC FREEDOM IN ITALY

NEXT summer the International Physiological Congress is scheduled to meet in Rome. In this connection I wish to call the attention of the members of the Federation of American Biological Societies, who are members of this congress, to the official edict issued by the Italian government on October 8, 1931, compelling all professors in Italian universities to swear allegiance to the Fascist régime. As announced in *School and Society* for January 9, eleven university professors out of 1,225 have refused to take this oath of allegiance.

I wish to propose to the members of the Federation of American Biological Societies for the coming meeting in Philadelphia in April the consideration of refusing to attend the International Congress of Physiology in Rome August next unless this brutal and defiant attack on academic freedom on the part of the Italian government is rescinded.

(*Signed*) A. J. CARLSON

DEPARTMENT OF PHYSIOLOGY,
UNIVERSITY OF CHICAGO
MARCH 4, 1932

SCIENTIFIC BOOKS

The Universe of Modern Physics. By MAX PLANCK. W. W. Norton and Company, Inc., 1931.

THE revolution of thought which had its inception in two physical theories, relativity and quantum mechanics, has swept over larger and larger fields of human concern. It has drawn into scientific controversy, and caused a revision of, some of the concepts that were considered to lie at the very basis of philosophical and physical thought. In the midst of the multifarious and conflicting attempts of reformulation we hear the voice of Planck, the man whose work was largely responsible for the abandonment of classical reasoning in physics. He addresses not the comparatively few who work in the special fields of theoretical physics, but all those who have an interest in the basic problems of physical reality. And his message is certain to be received with greatest attention.

Physicists are entirely too prone to forget the relations between their science and the fundamental issues of epistemology; indeed they frequently neglect to apply the test of logical consistency to the concepts which compose their theories. Planck's aim is to clarify these matters. He starts by stating the goal of physics, which he defines as the apprehension of true reality, a goal which is admittedly unattainable but acts as a guiding ideal in scientific investigations. Reality, in Planck's analysis, is more than the mere phrase it appears to be in many similar treatises: the world of reality is definitely set aside as one of three, the other two being the world of sense and that of physics. The latter is a deliberate hypothesis and is subject to change, while the world of reality is immutable.

The discussion of these metaphysical matters is followed by a lucid exposition of relativity and the quantum theory, particular emphasis being placed upon those points at which they break away from the more common habits of thought. Planck's comments on Heisenberg's principle of uncertainty are very noteworthy indeed, for he makes a point which is too often overlooked in the numerous illustrations of this principle: It "has nothing whatever to do with any measurement," but derives its validity only from the wave nature of matter. Determinism is redefined, and its premises are then shown to apply to wave mechanics, so that uncertainty can not be said to be contradictory to determinism. Nevertheless, there is an important distinction between determinism in classical physics and in quantum physics. Classically, the configuration of objects was governed by definite laws; in quantum mechanics complete determination fixes the state of material waves. This situation is not opposed to strict determinism; it merely renders considerably looser the relation between the physical world and the world of sense.

Causality, complete physical lawfulness are in Planck's opinion the bases of physical science. He regards causality as a category which is given *a priori*, much in the Kantian sense. The definiteness of his statements on this controversial point is truly pleasing, and it is to be hoped that the soundness of the author's view will penetrate the mist which still be-

clouds this important problem. On the basis of the supposition of lawfulness the physicist proceeds to erect his science, and his efforts are governed very largely by working hypotheses, whose rôle and importance are discussed. Interesting examples taken from the history of physical thought illustrate the making of physical theories. After discussing the genesis of physical laws Planck examines their contents. He finds that, from this point of view, all laws can be divided into two main groups: those governing reversible and those governing irreversible processes. While it is impossible on logical or empirical grounds to decide whether one type of law is derivable from the other, Planck wishes to uphold the postulate that all laws are ultimately of a dynamical character, this being essential for the healthy development of physics.

Attempts have frequently been made to establish freedom of will on the basis of physical uncertainty. Planck shows convincingly how unnecessary such endeavors are, for he proves with his usual clarity that "human free will is perfectly compatible with the universal law of strict causality." In concluding he discusses some of the difficulties with which modern theories are still confronted, and points out the value which might arise from a coordination of scientific and philosophic endeavors.

The book contains in its 114 pages not only a considerable amount of valuable information accessible to those not specifically versed in science but it presents the views of a man who has left his permanent imprint upon the subject of which he speaks. Minor technical errors are only too likely to appear in a book of such broad perspective; there seems to be one on page 31 where the author, speaking of points at which the potential energy exceeds the total energy, is apparently referring to states where the total energy is negative. Some might find, too, that space should have been given to Dirac's more recent theories—but all such criticisms would seem pedantic.

HENRY MARGENAU

YALE UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION OF THE OSBORNE-MENDEL SALT MIXTURE CONTAINING ONLY INORGANIC CONSTITUENTS

IN a salt mixture used in compounding synthetic diets for experimental animals, it has seemed to us to be desirable to use purely inorganic salts because of the possibility that the citrates and lactates, commonly used in salt mixtures, may contain unsuspected vitamins. The salt mixture given below, in addition to fulfilling the requirement as to purely inorganic sources, is easily prepared from readily available C. P. chemicals with very little grinding and does not cake on standing. Moreover, it contains the inorganic radicals of Osborne and Mendel's milk salts to give in 1 kilogram of completed ration essentially similar amounts of the necessary constituents that this last would give in the proportion recommended, and thus should be equivalent for feeding purposes.

For convenience in comparing the present salt mixture with that of Osborne and Mendel,[1] as well as with McCollum's No. 185,[2] and Hawk and Oser's[3] recently suggested mixture, the 4 mixtures have been calculated to a 1 kilogram finished salt basis (Table I). As different proportions of salt mixtures in the

TABLE I

INGREDIENTS TO GIVE 1 KILOGRAM SALT MIXTURE

	O. and M.[1] grams	McC. No. 185[2] grams	H. and O.[3] grams	Suggested grams
NaCl		46.7	77.41	105.0
KCl			125.29	120.0
KH_2PO_4				310.0
$Ca_3(PO_4)_2$				149.0
$CaCO_3$	310.2		68.90	210.0
$MgSO_4$ (anhydr.)		72.0	38.50	90.0
$FePO_4 + 4H_2O$				14.7
$MnSO_4$ (anhydr.)	0.182		0.161	0.20
$K_2Al_2(SO_4)_4 + 24H_2O$	0.0564		0.0925	0.09
$CuSO_4 + 5H_2O$				0.39
NaF	0.571		0.508	0.57
KI	0.0460		0.0414	0.05
$NaH_2PO_4 + H_2O$		93.8		
K_2HPO_4		257.7	219.72	
$CaH_4(PO_4)_2 + H_2O$		146.0	113.25	
Ferric citrate + $1\frac{1}{2}H_2O$	14.59	32.0	13.00	
Ca lactate		351.8		
Ca citrate			309.67	
$MgCO_3$	55.67		33.43	
Na_2CO_3	78.78			
K_2CO_3	325.1			
H_3PO_4	237.4			
HCl	122.8			
H_2SO_4	21.16			
Citric acid + H_2O	255.4			

[1] T. B. Osborne and L. B. Mendel, *J. Biol. Chem.*, 37, 557, 1919.

[2] E. V. McCollum, O. S. Rask and J. E. Becker, *J. Biol. Chem.*, 77, 753, 1928.

[3] P. B. Hawk and B. L. Oser, SCIENCE, 74, 369, 1931.

ration are recommended by these investigators, a comparison is also given (Table II) of the percentage of

TABLE II

PERCENTAGE OF RATION

	O. and M.[1] per cent.	McC. No. 185[2] per cent.	H. and O.[3] per cent.	Suggested per cent.
Salt mixture	4.0	3.7	4.4	3.5
Na	0.137	0.126	0.134	0.145
K	0.737	0.427	0.721	0.533
Ca	0.496	0.256	0.489	0.500
Mg	0.064	0.054	0.0766	0.0636
Fe	0.0120	0.0243	0.0118	0.0129
Mn	0.000265		0.000258	0.000255
Cu				0.000348
Al	0.000013		0.000023	0.000018
PO_4	0.920	1.169	0.906	1.098
SO_4	0.083	0.212	0.135	0.251
Cl	0.478	0.105	0.468	0.423
F	0.00103		0.00101	0.000903
I	0.000144	*	0.000144	0.000134

* Iodine in drinking water.

the inorganic radicals in a diet prepared with the prescribed proportions of salt mixture to ration.

The suggested mixture has been used in essentially the present form for several years in this laboratory. Copper has added recently in accordance with the findings of Waddell, Steenbock and Hart[4] and Elvehjem and Hart.[5]

LAURENCE G. WESSON

VANDERBILT MEDICAL SCHOOL,
NASHVILLE, TENNESSEE

A NEW KAHN ANTIGEN MIXER

THE proper mixing of the Kahn antigen with salt solution in order to obtain a stable and uniform emulsion is still something of a problem, notwithstanding the improved mixers available on the market.

In this laboratory and in that of Agnew State Hospital we have used a mixer which possesses definite advantages over all others and which is inexpensive to make. It is nothing more than a Hatschek emulsifier in miniature. Its operation is simple.

[4] J. Waddell, H. Steenbock and E. B. Hart, *J. Biol. Chem.*, 84, 115, 1929.

[5] C. A. Elvehjem and E. B. Hart, *J. Biol. Chem.*, 84, 131, 1929.

The materials used are as follows:

(1) A specimen vial $\frac{3}{4}$ inch inside diam. by $2\frac{3}{4}$ inches long

(2) 1 rubber stopper No. 3 with 2 holes.

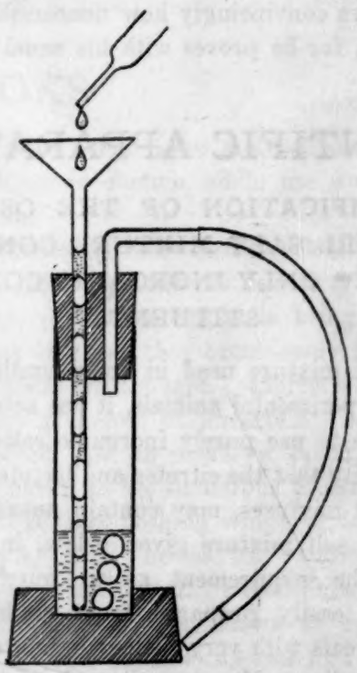
(3) A 1 inch funnel with a stem 4 inches long.

(4) A $1\frac{1}{2}$ inch right angle glass tube, $\frac{1}{8}$ inch inside diam.

(5) A piece of rubber tubing 9 inches long by $\frac{3}{8}$ inch diam. with glass tubing mouth-piece.

The end of the funnel is heated until the hole is $\frac{1}{2}$ mm. in diameter. When inserted through the rubber stopper and the vial closed the funnel stem should almost touch the bottom. For greater stability the base of the vial can be held in a No. 9 rubber stopper.

The antigen is put into the vial first. After the stopper is replaced, gentle suction by mouth or otherwise is applied by means of the rubber tube connected with the right angle glass tube. This causes bubbling



through the antigen. Now the salt solution is poured into the funnel one drop at a time—say 2 or 3 drops per second. The entrapped air between the drops does the mixing of the salt solution with the antigen in the vial. If mechanical suction is used and also a dropping funnel it is possible to reproduce the mixing exactly each time and standardize the emulsion with great accuracy; something almost impossible with the mixers in general use. Since this mixer has been in use, a marked decrease in doubtful determinations has taken place.

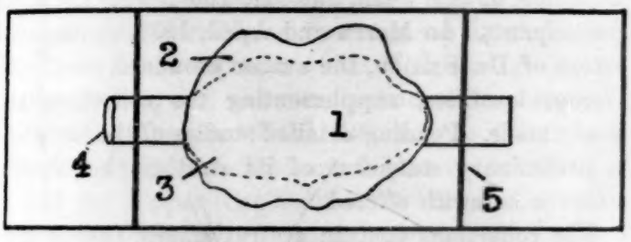
CHARLES GURCHOT

RESEARCH LABORATORY,
SONOMA STATE HOME,
ELDRIDGE, CALIFORNIA

A SIMPLE METHOD FOR THE STUDY OF LIVING FRESH-WATER SPONGES

THE pores, oscula and superficial canals of fresh-water sponges can be readily seen with the aid of a good lens. The many branching canals which extend throughout the sponge body, the flagellated chambers and the cellular structure, however, can not be easily studied on the living sponge. All these structures may be demonstrated by a very simple method.

If a small healthy sponge or a portion of a larger one is placed on a glass slide at the bottom of a dish of pond water (water 2 to 3 inches deep) it will soon adhere to the slide and grow out on the surface of the glass as a thin incrustation. If the sponge used is growing on the stem or leaf of a water plant it will tend to float. In this case the stem (4) or leaf should be tied to the glass slide by



pieces of thread (5), as shown in the diagram. The slide should be changed to fresh pond water every twenty-four hours. Generally a thin marginal membrane, attached to the slide around the sponge mass, appears within twenty-four hours. By the end of the second day a wide area (2, 3) of sponge tissue has grown from the original mass, and by the end of the third day large canals are easily seen in this area without the aid of a lens. If the sponge used is small, all the tissue deserts its original substratum and moves out on the slide. If the original sponge is large the thick portion (1) may be carefully cut away without injury to the encrusting mass. The slide may then be taken from the dish, covered with a thin cover glass, and studied with the oil immersion objective if necessary. At the periphery of the mass there is a thin marginal membrane (2) in which the various types of amoeboid cells may be more easily studied. The inclusions of these cells are more clearly seen if a very dilute solution (1–10,000) of some vital stain such as Nile blue or methylene blue is added. In the thicker part of the incrustation (3) the flagellated chambers, with the actively beating flagella are seen. These preparations may be studied for long periods, provided water is added at the edge of the cover glass quite often. The cover may be removed without injury to the sponge and the slide returned to the pond water for future study, or the specimen may be fixed on the slide and a permanent stained mount prepared.

JAMES T. PENNEY
UNIVERSITY OF SOUTH CAROLINA

SPECIAL ARTICLES

INSECTS AS VECTORS OF YELLOW DWARF OF ONIONS[1]

FOR the past few years onion growers in the vicinity of Pleasant Valley, Iowa, have been greatly concerned over a virus disease of the onion, known locally as "yellow dwarf," and the means by which it is disseminated under field conditions. During the season of 1928 losses from this malady amounted to as high as 95 per cent. of the crop in some plantings. At that time field observations made it quite evident that some agent, perhaps an insect, was responsible for the spread of the disease. Since 1928 yellow dwarf has not been so prevalent in the fields nor so severe in its attack, a result largely due to the practice of using only disease-free sets. Such sets were secured either from localities where yellow dwarf had never appeared or from fields within the infected area free or almost free of the disease as determined by indexing. During this period, however, it remained constantly evident that there was dissemination in the field by vectors.

While making a survey of the insect pests attacking onions in Iowa the writers, aside from studying the forms that might be called of primary and secondary importance, have given attention to several species which are not able normally to subsist on onion, but which, nevertheless, occasionally or only incidentally feed upon it. Although many tests have been made with members of the former groups it has from the first seemed probable that in the latter would be found the vectors of the virus.

Yellow dwarf, or "crinkles" as it is sometimes called, is so named because of its most characteristic symptoms—*viz.*, yellowing and stunting of the plant, accompanied by drooping and frequently by crinkling and chlorosis of the leaves. Under certain conditions the symptoms may be completely masked until after the bulbs have undergone a rest period and then have been regrown. Such plants may serve as a means of carrying the disease from season to season and as a

[1] Journal Paper No. B40 of the Iowa Agricultural Experiment Station.

source of infection to insect vectors. The disease is not tranmitted through the seed.

In the insectary at Ames yellow dwarf has been transmitted to a large number of onion plants by three species of aphids[2]—the bean aphid (*Aphis rumicis* Linn.), the corn leaf aphid (*Aphis maidis* Fitch) and the apple grain aphid (*Rhopalosphium prunifoliae* Fitch), and by the six-spotted leaf-hopper (*Cicadula sexnotata* Fall.). Observations indicate that the bean aphid and the corn leaf aphid are responsible for a large percentage of the transmission of the disease. These two plant lice are quite common in the fields at Pleasant Valley and feed very readily on the leaves of the onion. Moreover, cage experiments with these two forms gave the highest percentage of transmission. The apple grain aphid does not feed as readily on the onion and only a few cases of transmission were secured with it, as was also the case with the six-spotted leaf-hopper. Although the latter is very common in the fields and readily feeds upon the onion plant further experimentation is needed to substantiate its rôle as an important vector of yellow dwarf.

For the experiments the different species of aphids were reared in separate rooms on some of their preferred hosts. From eight to twelve individuals of a species, after having been confined on a diseased plant for twenty-four hours, were transferred to disease-free plants in individual cages. When so confined on an onion, practically all the aphids died within a period of three to six days. In more than 200 definite transmissions the symptoms of yellow dwarf appeared on an average of seven to twelve days after the initial exposure to feeding by viruliferous lice. Plants thus infected were then successfully used as sources of inoculum to infect other plants. As controls, plants not exposed to the feeding of lice and plants supporting lice which had not been exposed to a source of inoculum were used. The symptoms of the disease have not yet appeared in any of these control plants, whereas in those exposed to aphids which had previously fed on diseased plants a high percentage of infection has resulted. In fact, in more than 100 tests during the month of February, 1932, 91 per cent. of the caged plants showed typical disease symptoms within 12 days.

The viruliferous aphids were confined on seedlings, sets and mother bulbs in various types of cages. In a number of tests the vectors were limited to small portions of an individual leaf, whereas in others they were permitted to run at large over a caged plant and to feed upon any part of this plant. Regardless of the portion of the plant upon which the aphids had been confined the first visible evidence of the disease always made its appearance in the new shoots. Frequently, in the larger onions no indications of the disease were ever apparent in older leaves upon which the insects had been confined, whereas the new shoots of these plants disclosed typical symptoms of yellow dwarf.

C. J. DRAKE
H. M. HARRIS
H. D. TATE

[2] Aphidae determined by Dr. F. C. Hottes.

THE PRE-OLIGOCENE STRATIGRAPHY OF PORTO RICO

LATE in 1930 Mr. James Thorp, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, discovered fossils in moderate numbers in the older rocks of Porto Rico. The several localities found are situated in the central part of the island at points where fossils had not previously been reported. The discovery was followed by an energetic search, in which Dr. N. L. Britton, chairman of the Scientific Survey of Porto Rico and the Virgin Islands, Mr. W. D. Noble, of San Juan, and Mr. Thorp were the chief participants. In March and April, 1931, at the invitation of Dr. Britton, the author examined the fossiliferous localities, supplementing the collections already made. Pending detailed studies of the material, a preliminary statement of its stratigraphic significance is herewith offered.

The collections contain approximately twenty species in a sufficiently good state of preservation for specific description, and there are a dozen additional forms which give some promise of ultimate identification. The majority of the species either are new or are closely related to, and perhaps identical with, species known in the older rocks of other Antillean islands. The assemblage is dominantly molluscan, but it also contains one or two species of algae, at least three of corals, one echinoid and one or two belonging to the arthropods.

The rarest specimen is that of an ammonite, the third thus far discovered in Porto Rico.[1] With the two ammonites previously found, it has been referred to Dr. John B. Reeside, Jr., of the U. S. Geological Survey, who has kindly submitted the following opinion:

> The small specimen with strong sculpture (Fig. 6, right)[1] seems to me a *Barroisiceras* very close to *B. haberfellneri* (von Hauer) in the strict sense (*cf.* Grossouvre, Les ammonites de la Craie superieure, pl. 1, fig. la, 1b). The large fragment [among the recent discoveries] seems to be a *Parapuzosia* close to *P. corbarica* (Grossouvre). I do not know any forms like these in the Lower Cretaceous [but] think them to indicate middle Upper Cretaceous age—Coniacian of the European nomenclature.

[1] H. A. Meyerhoff and I. F. Smith, "The Geology of the Fajardo District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. II, pp. 224–225 and Fig. 6, 1931.

Among the other molluscan types the rudistids are at once most numerous and most significant. They are present in the majority of the newly discovered faunules, usually dominating them. The specimens do not appear referable to any described species but have much in common with the genus *Barrettia*, which characterizes the Upper Cretaceous of Jamaica. Several of the other molluscs are also related closely to Jamaican, Saint Thomas and Saint Croix forms of Upper Cretaceous age.

Fossils are not abundant in the older rocks of the Antillean islands, and this collection is larger and more varied than any other thus far reported. Its discovery promises ultimately to settle the differences of opinion that exist regarding the age of the pre-Oligocene rocks of Porto Rico,[2] and the facts already established warrant the following conclusions:

(1) The claim of E. T. Hodge[3] that the stratified rocks situated in the center of the island near Aibonito are Comanchean must be set aside. The specimen identified by Dr. Reeside as *Barroisiceras aff. habnerfellneri* was found in rocks which Hodge assigned to the Comanchean, and a reexamination of the unconformity which he postulated between the "Barranquitas-Cayey" shales of assumed Lower Cretaceous age and the Upper Cretaceous "Sierra de Cayey" conglomerates has shown the two formations to be clearly intergradational.

(2) Upper Cretaceous rudistids occur profusely in the "Rio Jueyes series," which, on the basis of a single specimen referred to the Eocene species *Venericardia alticosta*,[4] Hodge considered to be early Tertiary and Maury dated as Middle Eocene. Mr. Thorp and the writer visited the reported *Venericardia* locality and obtained a collection of rudistids from it.

(3) G. J. Mitchell[5] resolved Hodge's "Coamo Spring limestone," another postulated Eocene horizon, into two calcareous members, the Guayabal and Coamo tuff limestones, both of which he found to contain Upper Cretaceous rudistids.

(4) Mitchell[6] has demonstrated that Hodge's "Rio Descalabrados series," also assigned to the Eocene, is composed essentially of strata belonging to the "Rio Jueyes series" and Coamo Spring limestone," repeated in consequence of folding. Its limestone members contain Upper Cretaceous rudistids.

(5) The possible equivalence of the Corozal limestone and the Upper Cretaceous La Muda limestone has already been pointed out.[7] No additional support can be given that suggestion at present, but a study of the fauna of the Corozal limestone has demonstrated its Upper Cretaceous affinities.

Thus, nearly all the evidence adduced in arguing the presence of Lower Cretaceous and Eocene strata among the older rocks of Porto Rico has been contradicted by the discoveries of the past six years; and Matley and Earle's opinion that pre-Mesozoic materials are present in Porto Rico and the Virgin Islands is without foundation, other than the physical appearance of some of the rocks. The paleontological and stratigraphic data now at hand, although incomplete, indicate that all the ancient sediments and associated volcanic and intrusive igneous rocks are Upper Cretaceous, not only in Porto Rico, but also in the Virgin Islands.

HOWARD A. MEYERHOFF
MAYAGÜEZ, PORTO RICO

THE DEPENDENCE OF PHYSICS ON THE MATHEMATICAL PREPARATION

AT the beginning of last school year a number of questions in mathematics were prepared by the author to be given to the students of elementary physics at various institutions. The object of giving the test was to find out what correlation, if any, there is between the mathematical preparation of the student and his successes in the course of physics that he is about to take.

Some work of this kind was done at the University of Florida in 1929. The students of elementary physics were given an examination in the essentials of arithmetic and algebra, and the grades made in mathematics were later compared with those made in physics. As the correlations proved to be very high, it seemed worth while to ascertain this correlation on a larger scale by inviting the cooperation of a number of institutions in administering the necessary tests.

The institutions who cooperated in this enterprise were Cornell University, University of Virginia, Oberlin College, Virginia Polytechnic Institution, University of Richmond, University of West Virginia

[2] *Cf.* C. A. Matley and F. Higham, "The Basal Complex of Jamaica, with Special Reference to the Kingston District." *Quart. Jour. Geol. Soc.*, Vol. lxxxv, pp. 472 and *ff.*; also pp. 490–491, 1929; C. J. Maury, "Porto Rican and Dominican Stratigraphy," SCIENCE, n.s., 70: 1825, 609, 1929; H. A. Meyerhoff, "The Pre-Oligocene Stratigraphy of Porto Rico," SCIENCE, n.s., 71: 1838, pp. 322–323, 1930; C. J. Maury, "Correlation of Antillean Fossil Floras," SCIENCE, n.s., 72: 1862, pp. 253–254, 1930; H. A. Meyerhoff and I. F. Smith, *op. cit.*, pp. 219–229, 1931.

[3] E. T. Hodge, "The Geology of the Coamo-Guayama District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, pp. 138, 192–193, 1920.

[4] This specimen can not be found, and it is therefore impossible to verify the identification.

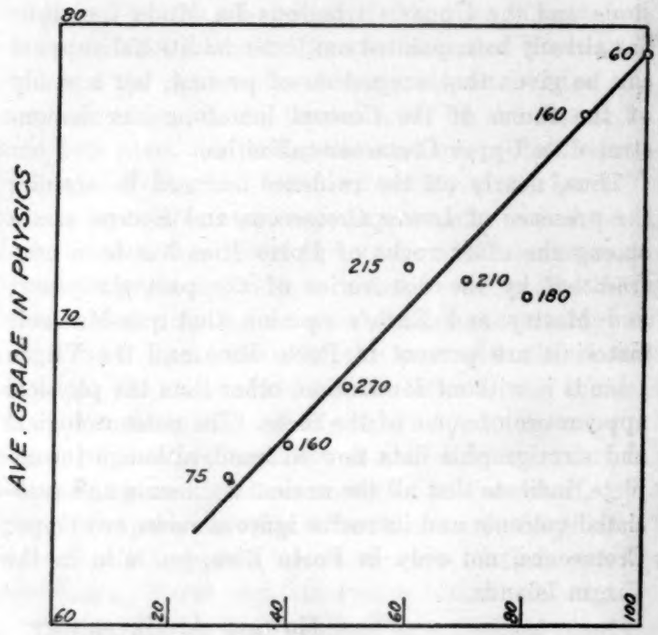
[5] G. J. Mitchell, "The Geology of the Ponce District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, 255–257, 1922.

[6] *Ibid.*, pp. 255–257; plate VI, section H-H'; geologic map. *Cf.* Hodge, *op. cit.*, pp. 161–164 and geologic map.

[7] H. A. Meyerhoff and I. F. Smith, *op. cit.*, pp. 221–225 and 263, 1931.

and Bowdoin College. The tests in mathematics were given at the beginning of the school year 1930-1931. The grades of the students made later in physics were sent to the author, and the results about to be presented were obtained from these reports.

Graph A represents the results of the comparison

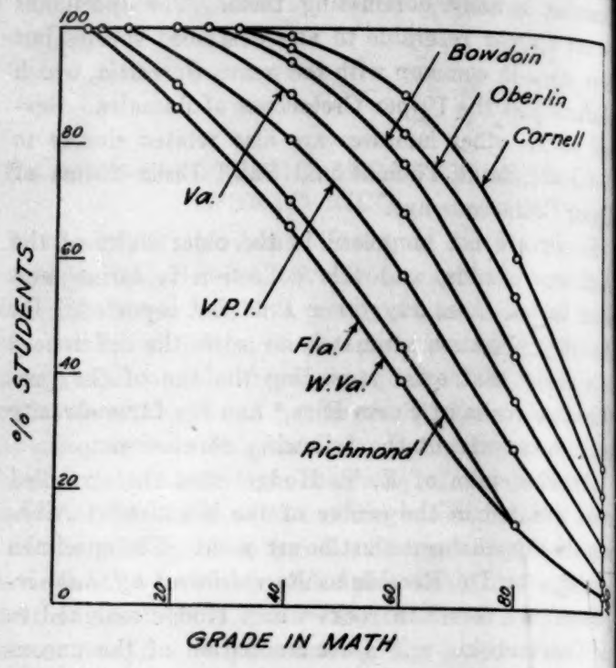


GRAPH A

of grades. Opposite each point is the number of students who made a given grade in mathematics. The ordinate is the average grade in physics made by these students. As is evident from the graph, the averages made in physics seem to be directly proportional to the grade which represents the mathematical preparation of the student. Only in the middle of the range, where the preparation is neither very good nor very bad, is it difficult to predict the success of the student in physics from his mathematical abilities.

In most institutions physics is considered one of the hardest courses on the campus. The number of failures in physics is usually very high. A great deal of this mortality is undoubtedly due to the very poor preparation of the student in the elements of the mathematics. After all, algebra and trigonometry is a part of the language of elementary physics, and if a student has to spend a great deal of time in unraveling the mysteries of this language he is bound to lose sight of the physical principles involved. It would seem advisable to give suitable tests in mathematics to all who are about to take the beginners' course in physics, and to dissuade from taking the course those students who show very poor preparation.

The results of the mathematics tests gave the opportunity also to compare the preparation of students in various colleges. In graph B, the percentage of the students in a given college is plotted against the



GRAPH B

mathematics grade these students have attained or exceeded. The three upper curves are those of the endowed colleges.

As it was to be expected, the students of the privately endowed institutions showed a much better preparation than the students of the state institutions. The average grade in the mathematics of the students in Cornell, Bowdoin and Oberlin is about 20 per cent. higher than the average grade of some of the state institutions of the South.

A. A. BLESS

UNIVERSITY OF FLORIDA

BOOKS RECEIVED

Annual of the American Schools of Oriental Research. Vol. XI, 1929–30. Henry J. Cadbury, Editor. Pp. viii + 169. Illustrated. Yale University Press.

GAGE, SIMON H. *The Microscope.* Ultra-violet edition (15th). Pp. viii + 589. 291 figures. Comstock. $4.00.

LEWIS, MELVIN S. and JOHN H. DILLON. *Instruction Sheets for the General Shop: Electricity.* Pp. viii + 91. Illustrated. McGraw-Hill. $.50.

NATIONAL RESEARCH COUNCIL. *Bulletin No. 84: Report of the Committee on Hydrodynamics.* Pp. 634. $4.50. *Bulletin No. 86: Bibliography of Bibliographies on Chemistry and Chemical Technology.* Pp. 150. $1.50. National Academy of Sciences.

OSBORN, CHASE S. *The Earth Upsets: The Story of Earth's Motion.* Pp. 216. Waverly. $3.00.

RICHARDSON, LEON B. *General Chemistry.* Revised edition. Pp. iv + 779. Illustrated. Holt. $3.50.

SMYTHE, WILLIAM R. and WALTER C. MICHELS. *Advanced Electrical Measurements.* Pp. x + 240. 110 figures. Van Nostrand. $3.00.